Comminution behaviour of the middle group ores

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PRESENTATION OUTLINE

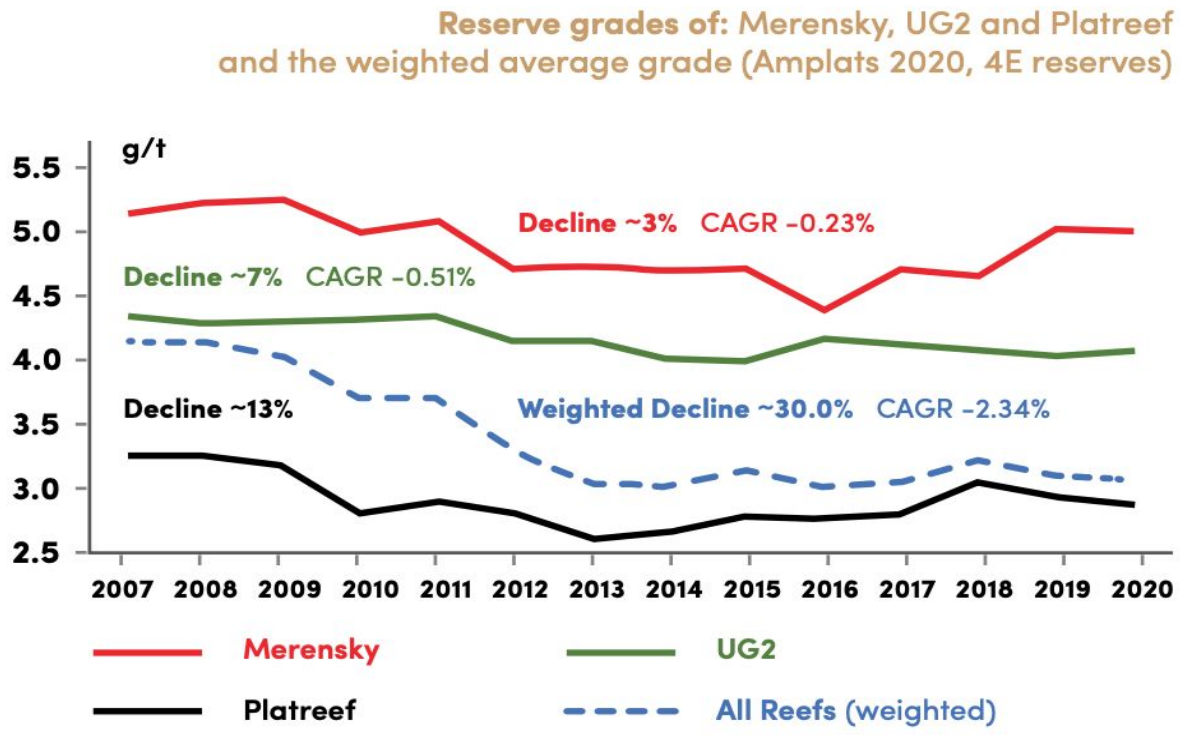
- Introduction
- Objective(s) of the study
- Methods & Materials
- Results
- Discussion & conclusions
- References

INTRODUCTION

BUSHVELD IGNEOUS COMPLEX

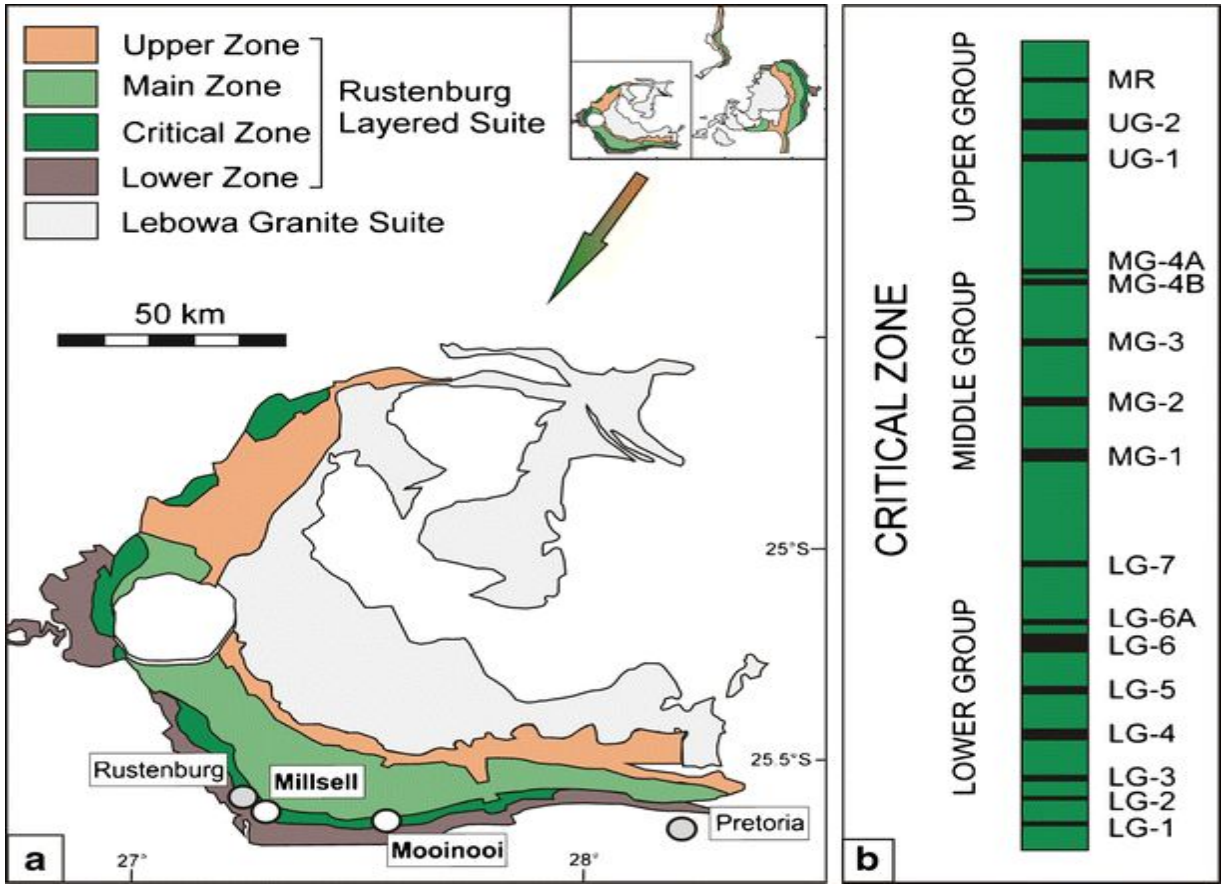
- Major Source of PGM's and Chrome
- Consists of western, eastern and the northern limbs
- Has an aerial extent of 65000 km2
- Thickness of up 8 km
- Mode of occurrence of PGM's varies
- High base metal sulphide content

INTRODUCTION



- Declining ore grades
- Increasing complexity
- Unstable world demand
- Government legislations
- Energy crisis

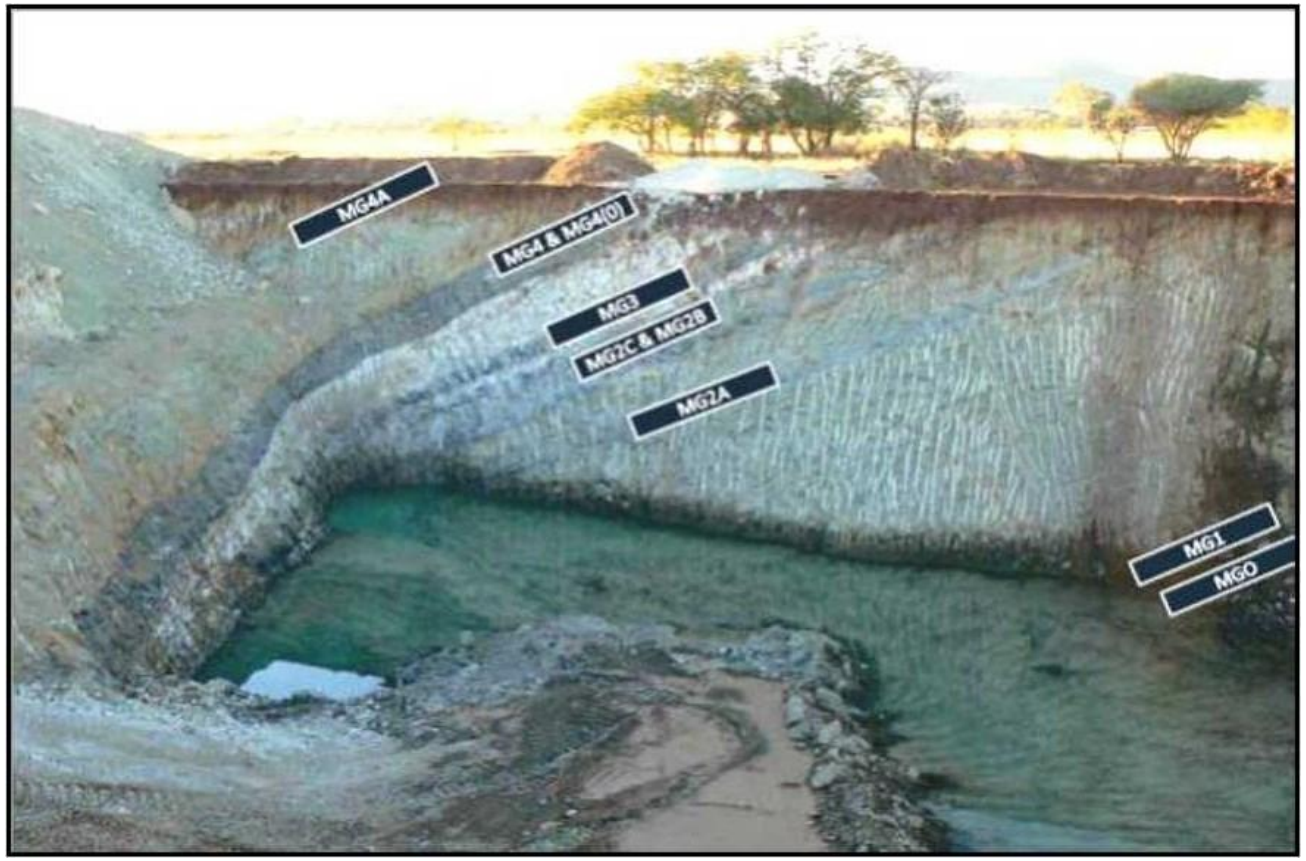
MIDDLE GROUP CHROMITITE

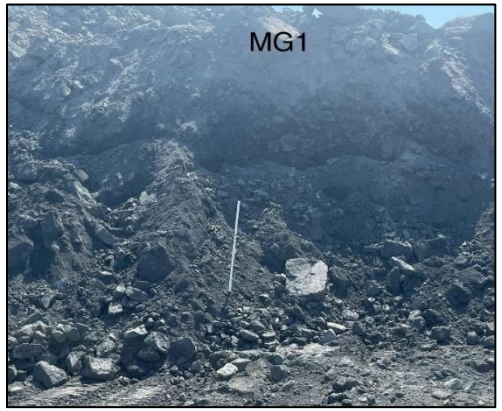


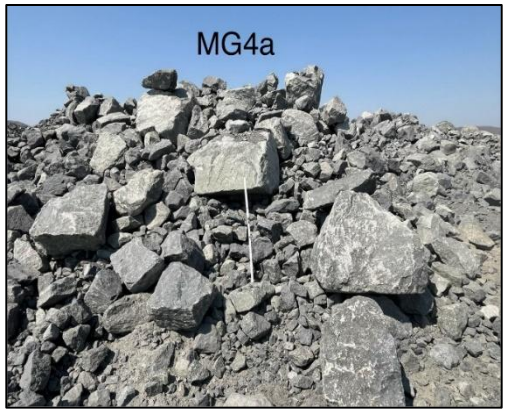
Middle group Chromitite reefs

- Received less attention:
  - mineralogical complexity
  - previously considered uneconomic
- Rarely exposed at surface
- Examined by fewer number of researchers
- Current Ore depletion (Volume and quality)

INTRODUCTION







AIM & OBJECTIVES

To investigate the comminution behaviour of MG ores:

- Rock Strength
- Grindability
- Batch Grinding
- Single Particle Breakage
- Abrasion Resistance

MATERIAL & METHODS

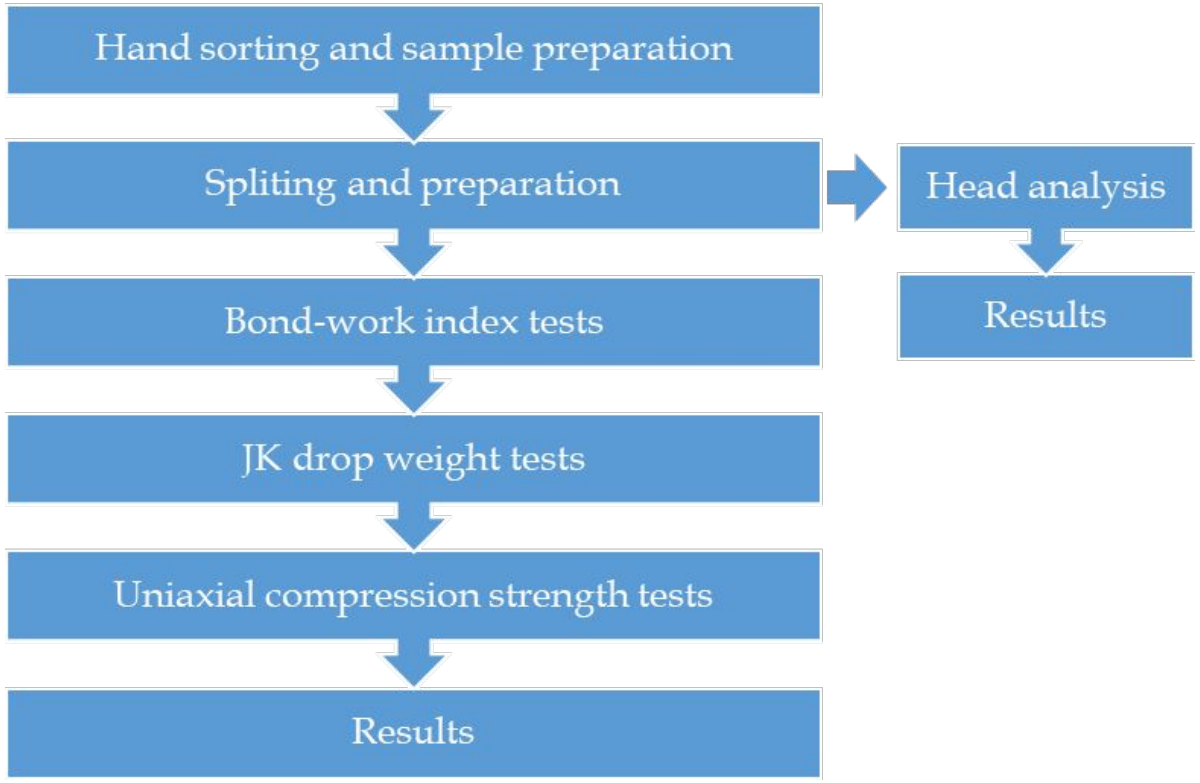


Figure 1: Representation of Flowsheet Overview for the Test-work Program

4E (3E + Au)

- PGM Grade (g/ton)
- Cr_2O_3 Grade (%)
- FeO (%)
- SiO_2 (%)

RESULTS

Table 1: Head sample analysis on different MG ores

Ore type	Pt(g/t)	Pd(g/t)	Rh(g/t)	Au (g/t)	3PGE+ Au (g/t)	Cr2O3 (%)	Cu (%)	Ni (%)	SiO2 (%)
MG1	0,32	0,2	0,11	0,004	0,634	32,1	0,002	0,077	22,54
MG2	0,98	0,28	0,15	0,004	1,414	19,33	0,002	0,061	41,83
MG3	0,6	0,35	0,15	0,005	1,105	17,99	0,003	0,047	35,11
MG4A	0,4	0,15	0,12	0,003	0,673	24,85	0,003	0,066	29,95

RESULTS CONT…

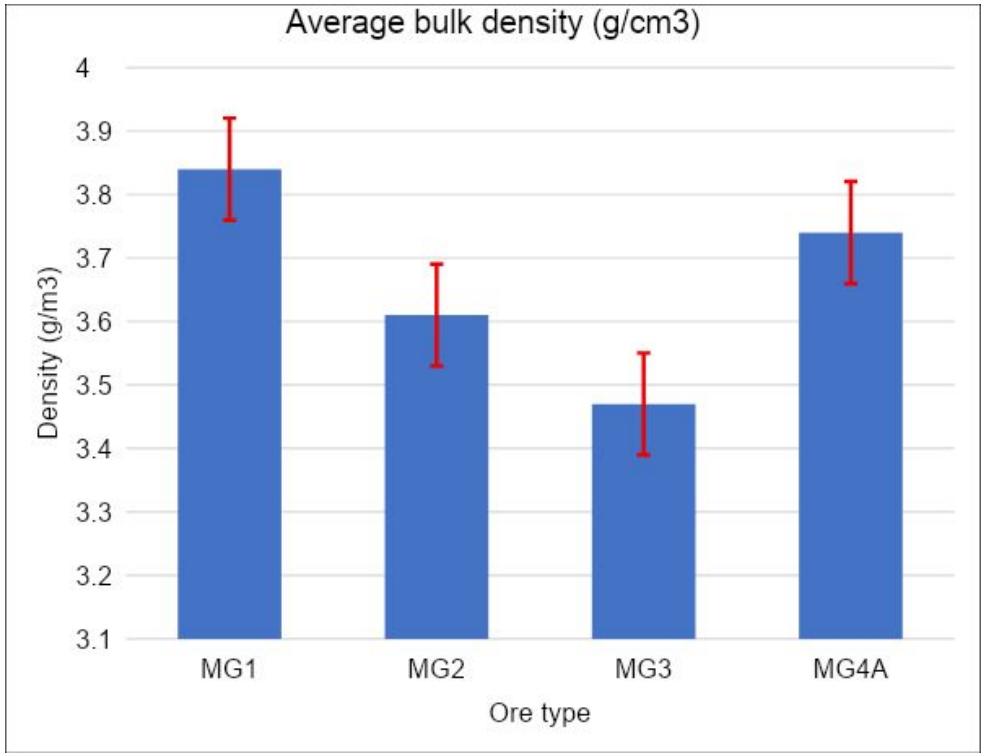


Figure 2: Average solid density on different MG ores

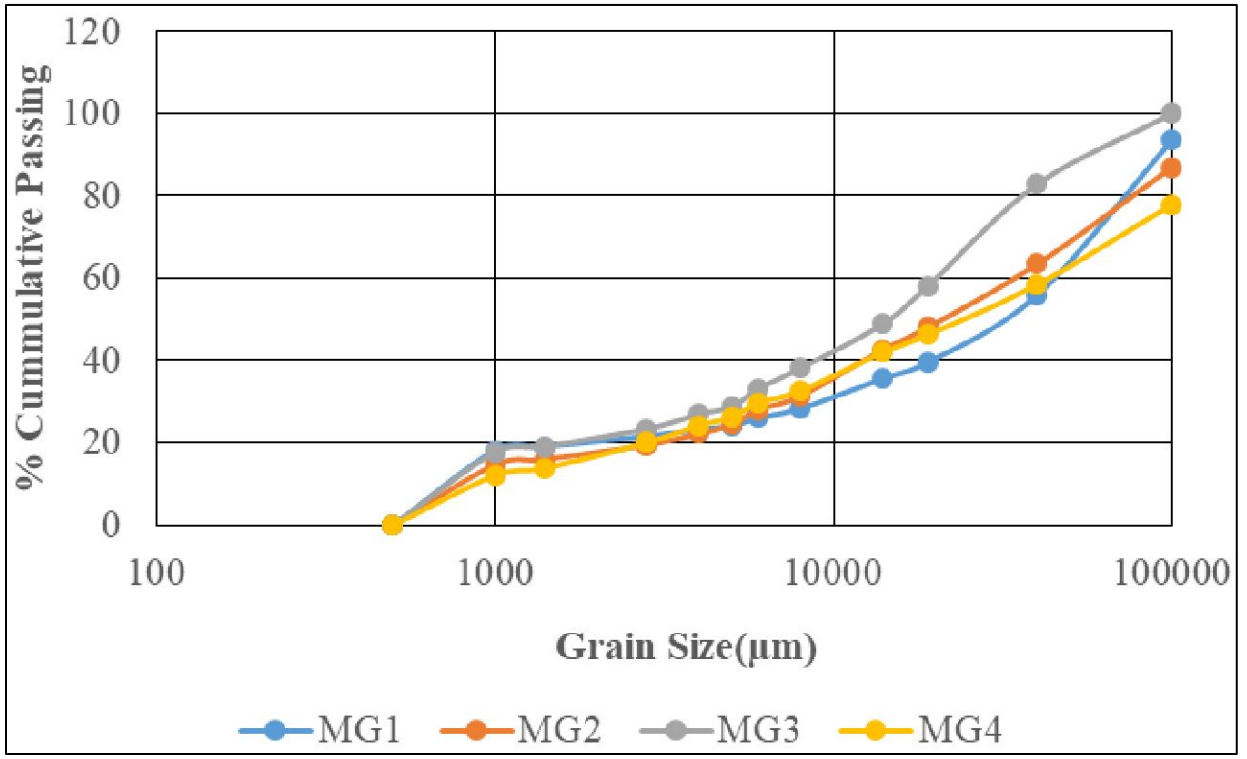


Figure 3: Particle Size Distribution of MG seams after blasting

RESULTS CONT…

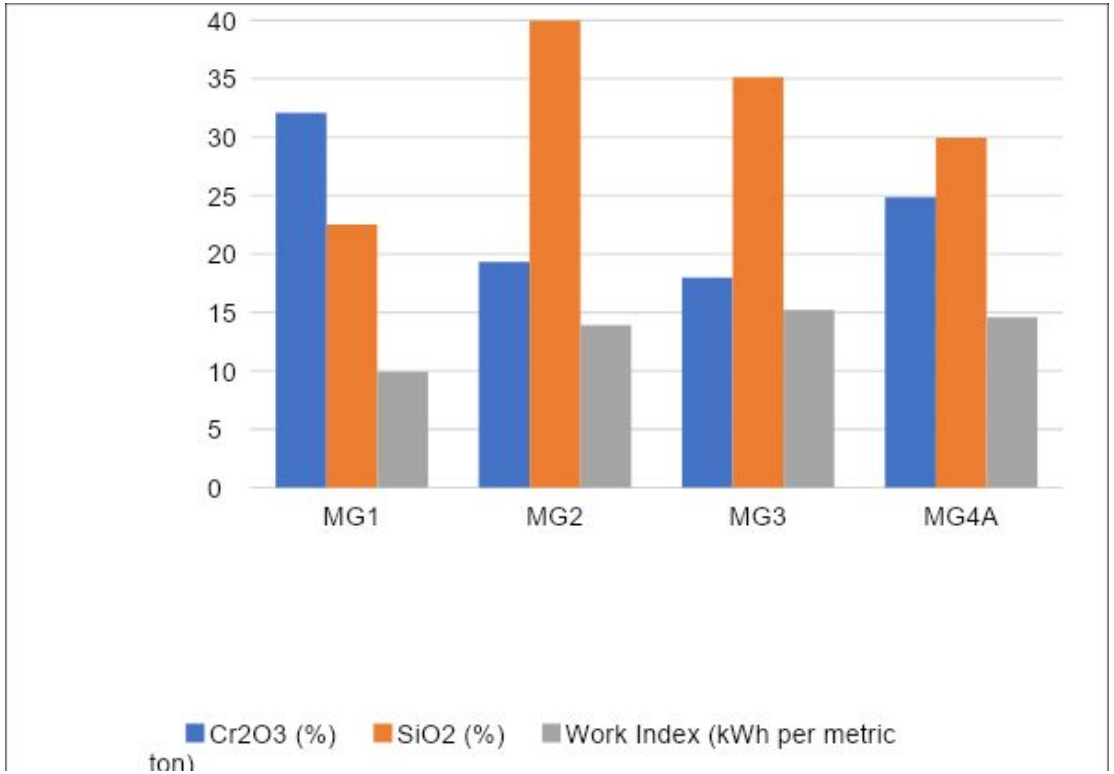


Figure 4: Bond Rod Work index vs Cr2O3 vs SiO2 of different MG ore types

Rock type	Limiting screen (microns)	F80 (microns)	P80 (microns)	Net generation (g/rev)	Work Index (kWh per metric ton)
MG2	106	2497.71	83.73	1.19	16.33
	212	2497.71	158.36	2.12	13.02
MG3	106	2532.44	89.58	1.22	16.68
	212	2532.44	157.15	1.93	13.94
MG1	106	2510.24	90.46	1.97	11.30
	212	2510.24	161.89	5.85	5.74
MG4A	106	2515.08	90.98	1.26	17.33
	212	2515.08	165.64	2.12	13.88

Table 3: Bond Ball Work Index on different MG ores

RESULTS CONT…

Table 4: Bond Crushability Work Index on MG ore type

Rock type	Work Index (kWh per metric ton)
MG2	16.3 ± 2.7
MG3	12.4 ± 1.9
MG1	7.0 ± 1.4
MG4A	14.35± 2.3

$$WI = 53.49 \frac{ICS}{SG}$$

where

ICS = impact crushing strength (J/mm)

SG = specific gravity of rock

WI = Work Index (kWh/t)

Table 5: Bond Crushability Work Index formulae

RESULTS CONT…

Table 5: Abrasion Index results for different rock type for MG ore

Rock type	Abrasion Index (g)
MG2	0.3114 0.2671
MG3	0.2710 0.2890
MG1	0.3760 0.4546
MG4A	0.2912 0.2781

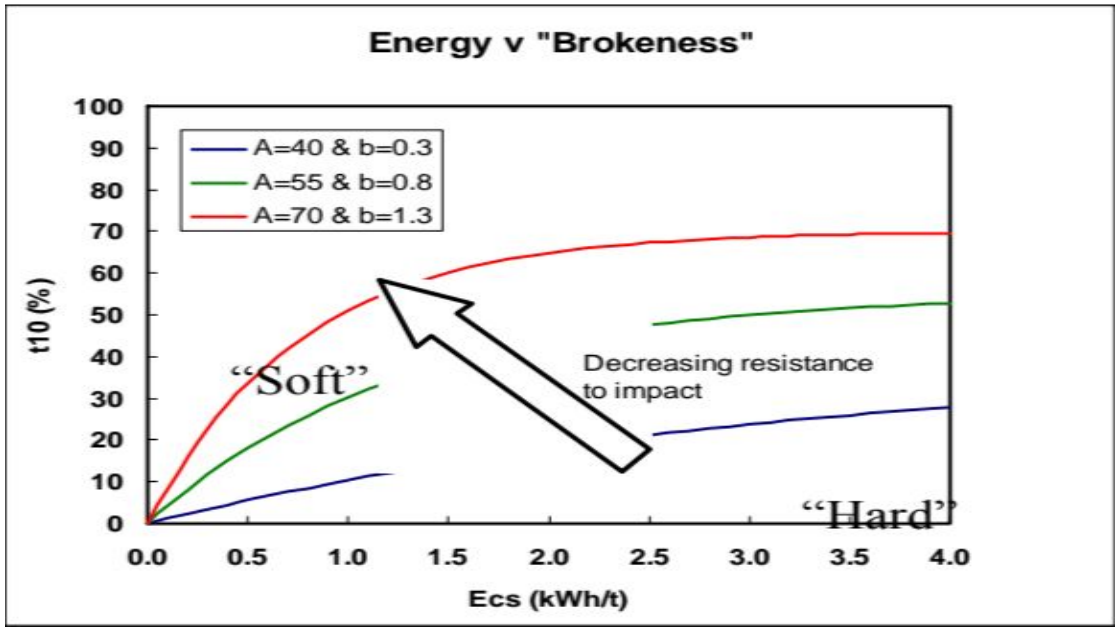
Table 6: UCS of different MG ore types

Rock type	UCS Strength (Mpa)
MG2	88 ± 21
MG3	72 ± 10
MG1	78 ± 24
MG4A	81 ± 21

RESULTS CONT…

Table 7: Abrasion Index results for different rock type for MG ores

Rock type	JK parameters			
	A	b	A*b	Ta
MG2	69.3	0.93	64.45	0.51
MG3	62.3	0.95	59.19	0.73
MG1	72.7	1.4	101.78	0.98
MG4A	65.8	0.94	61.82	0.62



DISCUSSION & CONCLUSIONS

- MG ores pose significant comminution challenges due to:
  - High Bond Work Indices
  - High UCS values
  - Variable impact breakage
- Key considerations for design:
  - Careful circuit design and operation
  - Appropriate test selection and interpretation

DISCUSSION & CONCLUSIONS

- Key takeaways:

  - Understanding ore characteristics is crucial (Mwanga, 2014)

  - Test selection depends on targeted particle size range (Morrell, 2004)

  - Size-specific testing: crushing, grinding, and ultra-fine grinding for different particle sizes.

END
Any questions?