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Presentation to

Mintek 75 – A Celebration of Technology

Automated SEM study of PGM distribution across a UG2
concentrate bank

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Outline

- Introduction
- Automated SEMs
- Parameters considered
- Data quality: uncertainties
- Parameter variation down the concentrate bank
- Preliminary conclusions and further work

Introduction

- PGM characterisation routinely carried out, what are the implications for floatability?
- Previously, batch flotation tests (Penberthy, 2001) determined floatability characteristics. Can these be related to a dynamic plant-scale system?
- Part of a larger study that critically assesses the BMS proxy, and PGM identification by automated SEM at sub-10 um levels, along with statistical assessment of data from automated SEM.

Introduction

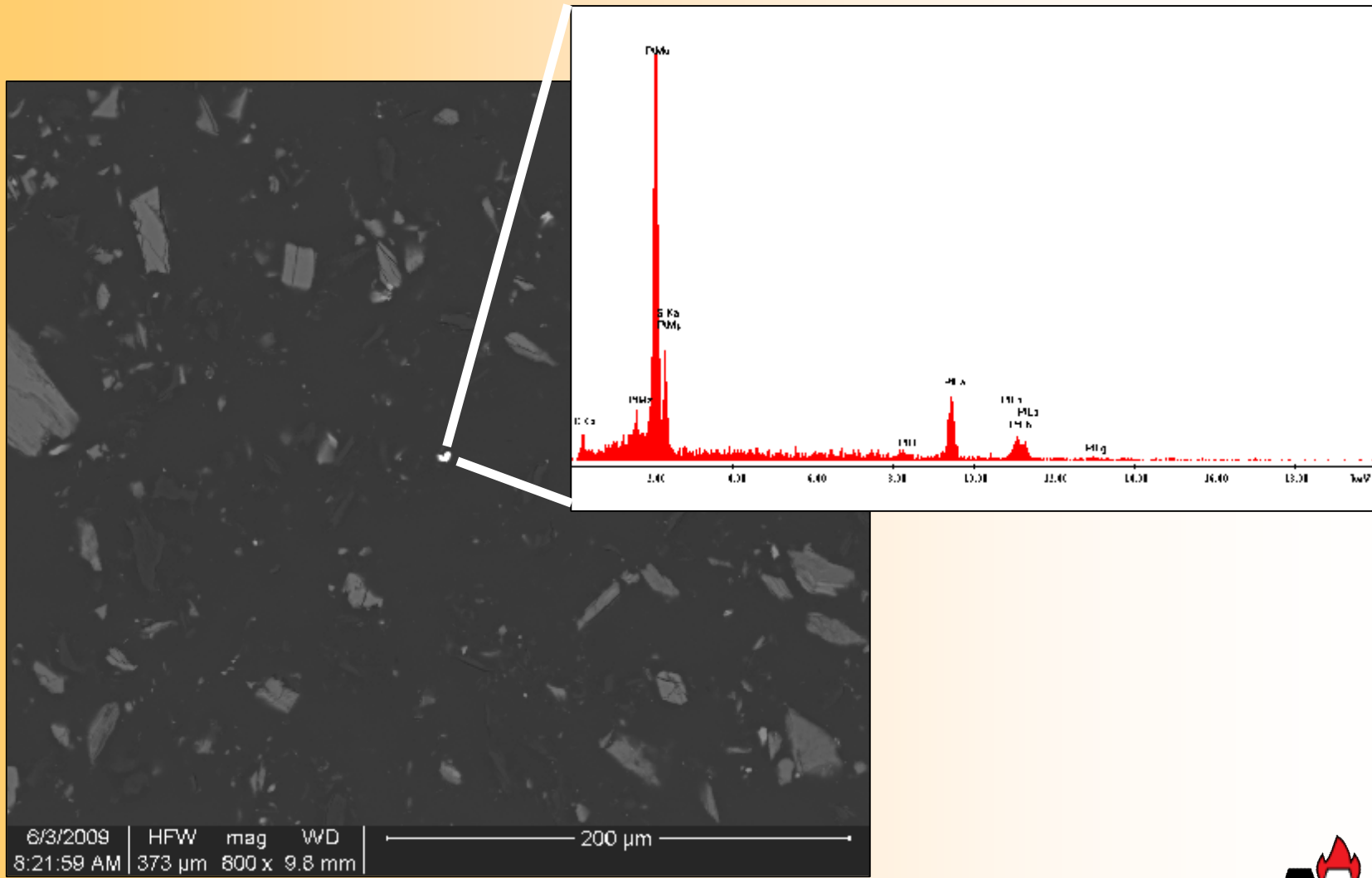
- Therefore, sampled a UG2 primary rougher circuit at a SA concentrator (more PGMs!)
- Aim: Can the floatability parameters we routinely use adequately resolve differences in PGM-bearing particle behaviour in the ten concentrate cells of the rougher circuit? Test of robustness of the PGM-bearing particle parameters, as determined by auto-SEM
- First results of ongoing investigation

Automated SEMs

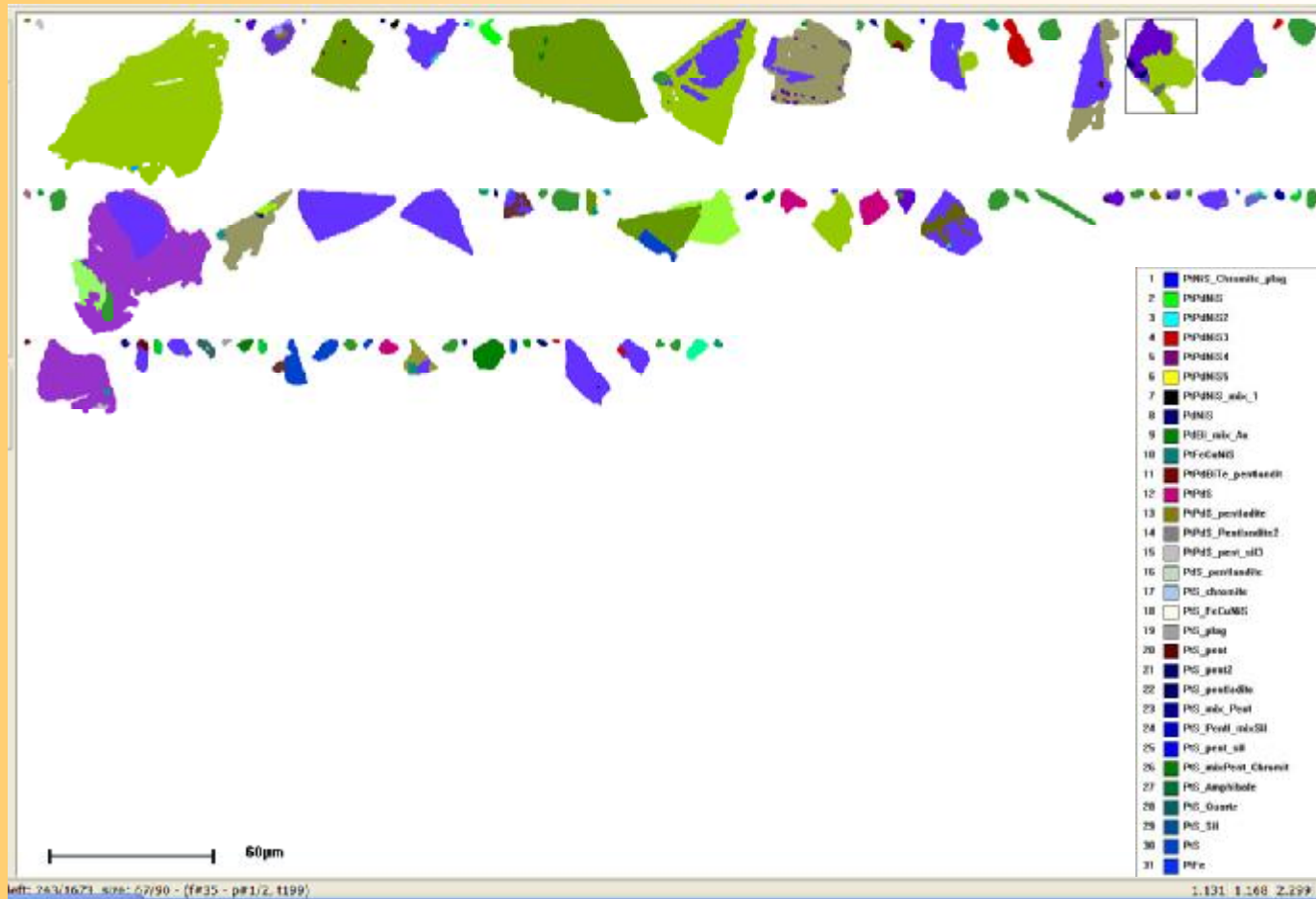
Arrived June
2008



Automated SEMs



Automated SEMs



Parameters considered

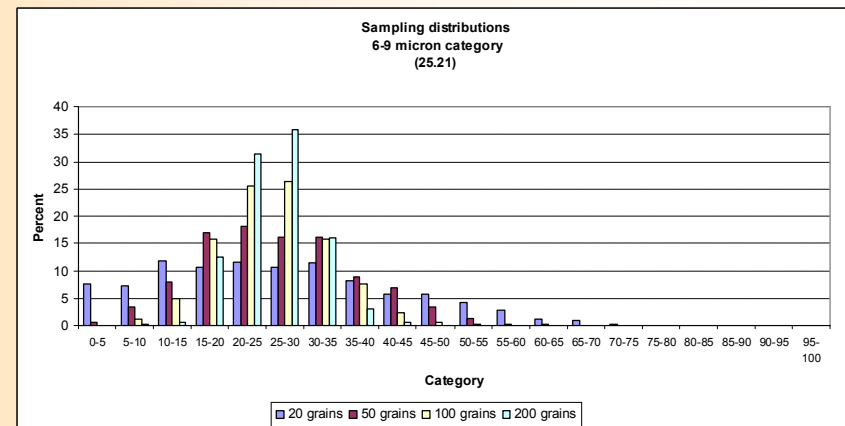
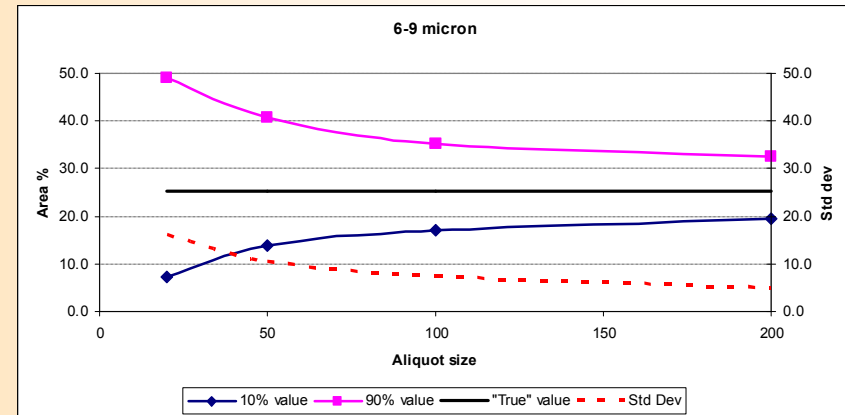
- PGM species
- PGM size distribution
- PGM mode of occurrence
 - liberation characteristics
 - mineral association (BMS and gangue)
- Floatability

Data quality

Sample	Number of grains
PRF	198
PRC1	784
PRC2	465
PRC3	338
PRC4	456
PRC5	360
PRC6	414
PRC7	321
PRC8	288
PRC9	410
PRC10	363
PRT	116
<i>TOTAL</i>	<i>4513</i>

Data quality

- Statistically valid interpretations?
- Comparing numbers, are they the same or different? We require uncertainties.
- Resampling statistics to obtain std deviations on mean values of different parameters, e.g. modal abundance of species, size classes of PGMs sampled.



Data quality

PRC1: 784 grains, resampled with 200 grain aliquots, 1000 simulations. Mean and uncertainty at 90% confidence level

PGM grouping	Modal abundance (%)	Uncertainty ($\pm\%$)
PGE Sulfides	93.65	3.34
PGE Alloys	4.24	3.13
PGE Arsenides	1.13	1.06
PGE Tellurides	0.75	0.84
PGE Bismuthotellurides	0.23	0.17

Size class	relative abundance (vol%)	Uncertainty ($\pm\%$)
0-3	5.75	1.08
3-6	30.76	4.96
6-9	25.83	4.96
9-12	14.24	4.74
12-15	6.29	3.67
15-18	4.84	4.05
18-21	4.87	4.87
21-24	2.33	4.15
24-27	0.00	0.00
27-30	0.00	0.00
>30	5.10	8.61

Data quality

- Automation, but time-consuming for what we want to achieve...

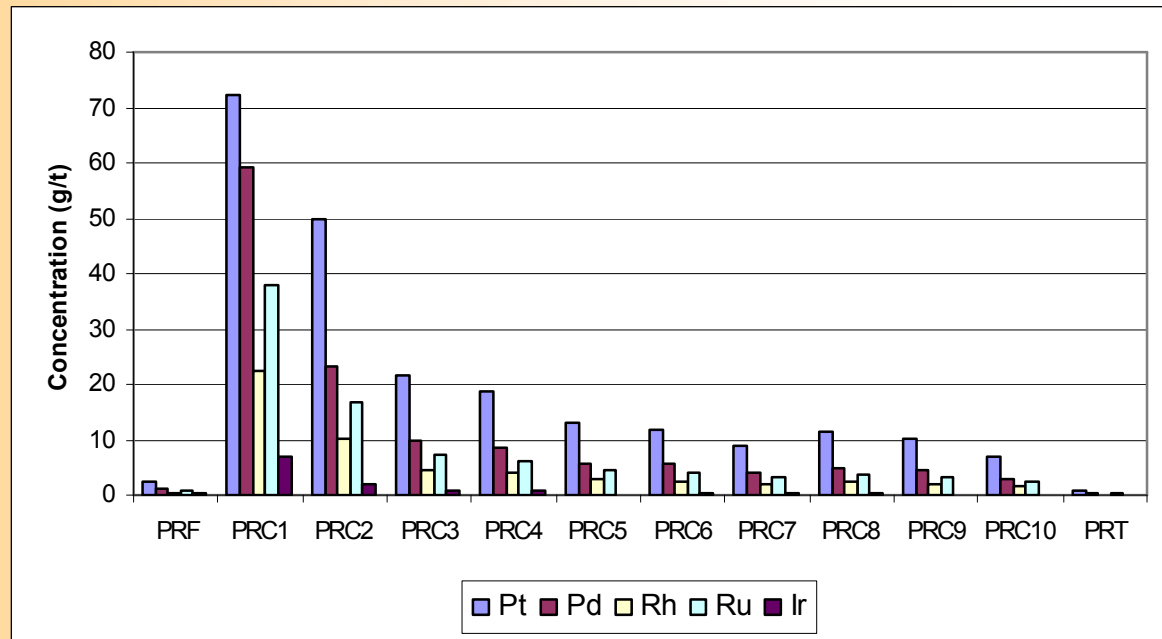
grains	Polished sections	run time (hours)	checking time (hours)	Total time (hours)
500	129	386	64	451
1000	8	38	31	69
1000	15	75	60	135
1000	38	173	154	327
1000	29	128	57	185
1000	36	163	72	235
1000	46	207	92	298
1000	53	212	106	318
1000	83	333	167	500
1000	71	283	141	424
1000	116	463	231	694
500	272	815	68	883
		hours	1243	4519
		days	155	188

- ... = 6 months. Add: 4 months for sample insertions and vacuum pumping, standards file establishment, offline processing, reporting and interpretation, at instrument efficiency of 80%, this is **~11 months** continuous work



Sample grades

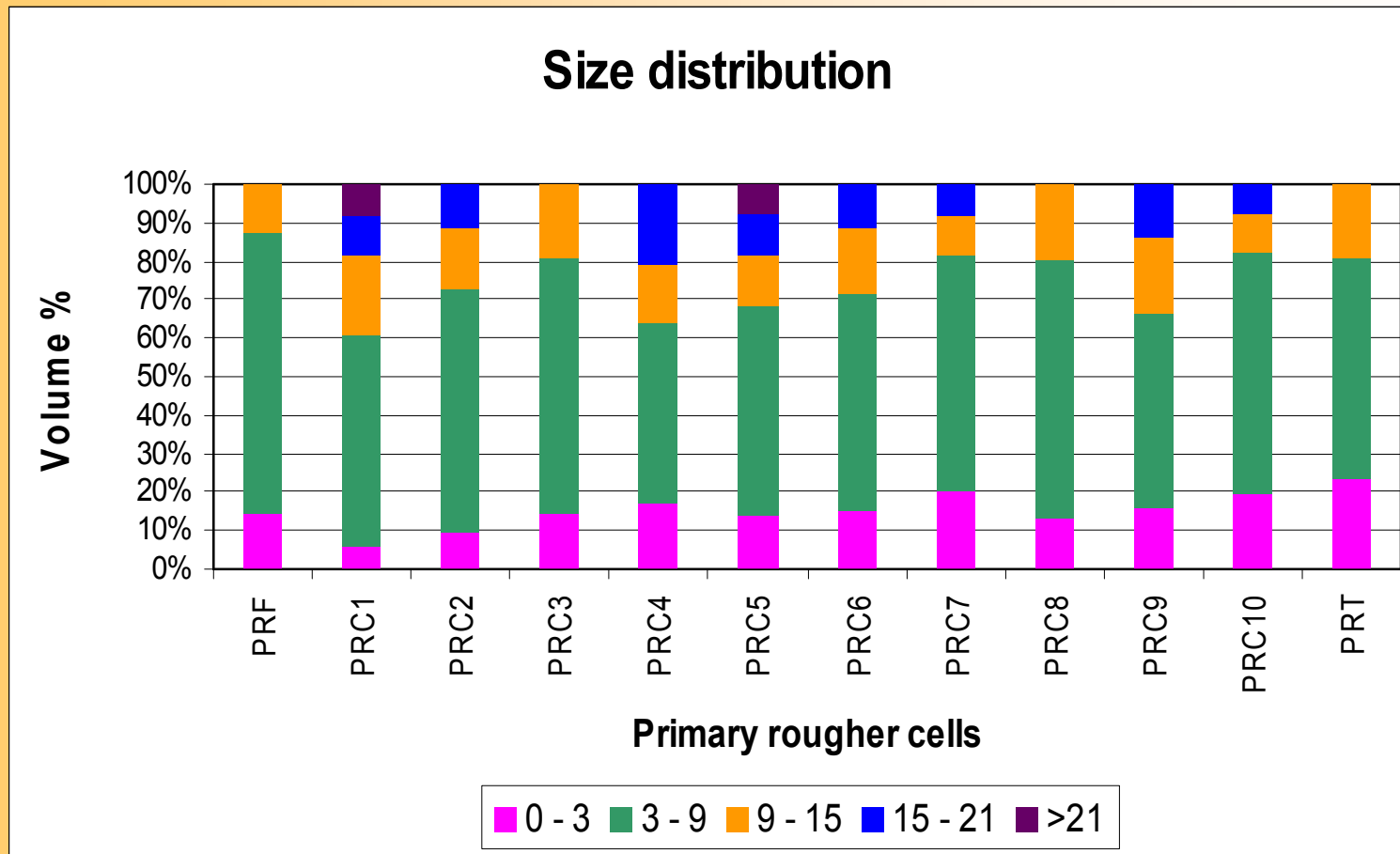
Sample	PGE (g/t)
PRF	5.41
PRC1	199
PRC2	102
PRC3	45
PRC4	38
PRC5	26
PRC6	25
PRC7	18
PRC8	23
PRC9	20
PRC10	14
PRT	1.61



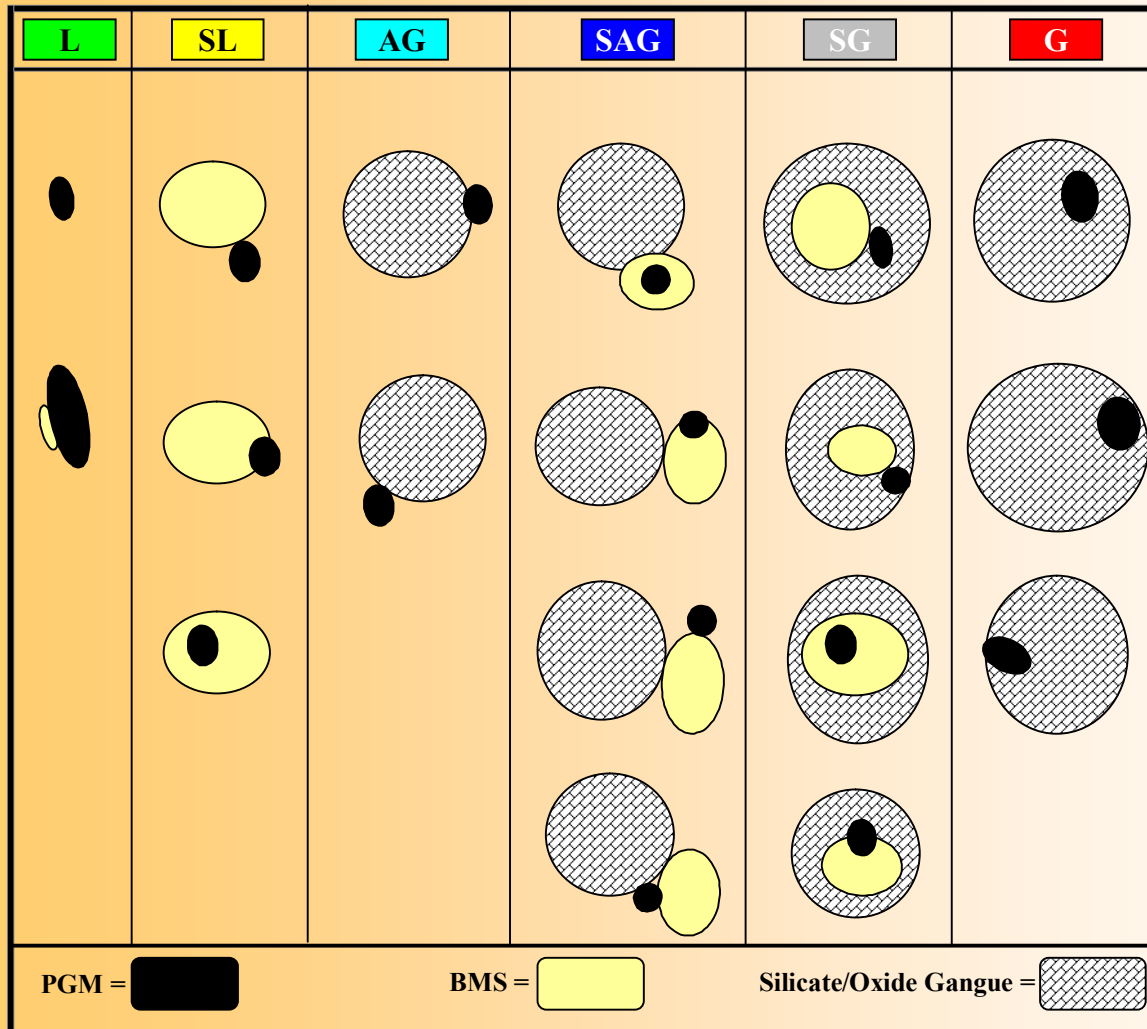
UG2 Feed composition

PtPdNiS	PGE Sulfides	93
PtS		
PtRhCuS		
PtRhAsS		
PtRhS		
PdS		
PtPdAsS		
PtPdRhCuS		
RuS		
PtFe		
PdHg		
PdPb		
PdAs	PGE Arsenides	0.1
PtAs		
PtRuAs		
PtTe	PGE Tellurides	2.5
PtPdTe		
PtBiTe	PGE Bismuthotellurides	0.9
PdBiTe		
PtPdBiTe		
PtPdAsSn	PGE Others	0.6
PdAsSn		
PdAsSb		

Size distribution



Mode of occurrence



L = Liberated
PGM

SL = PGM assoc.
with liberated
BMS

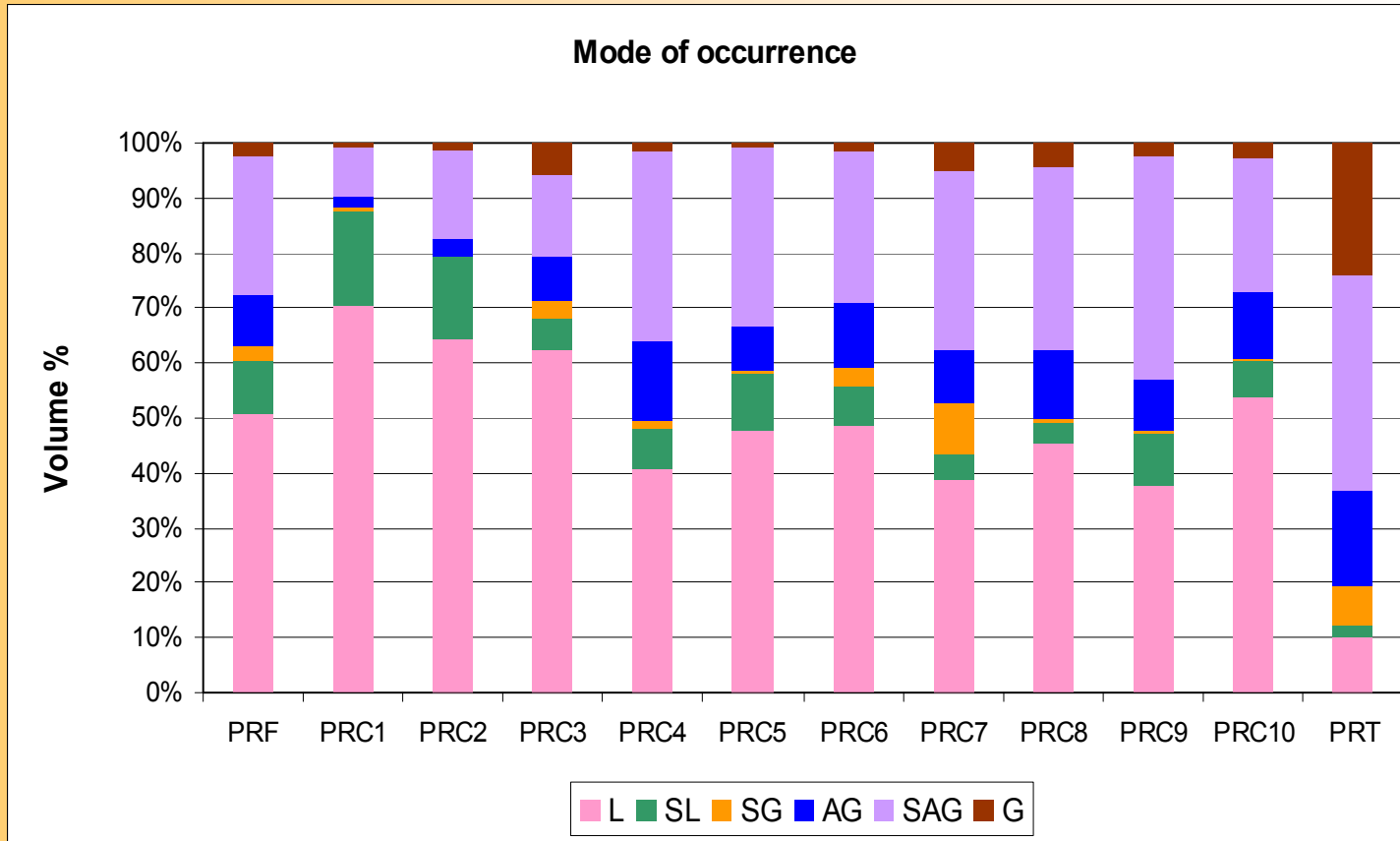
AG = PGM
attached to
gangue

SAG = BMS
attached to
gangue

SG = Locked
BMS

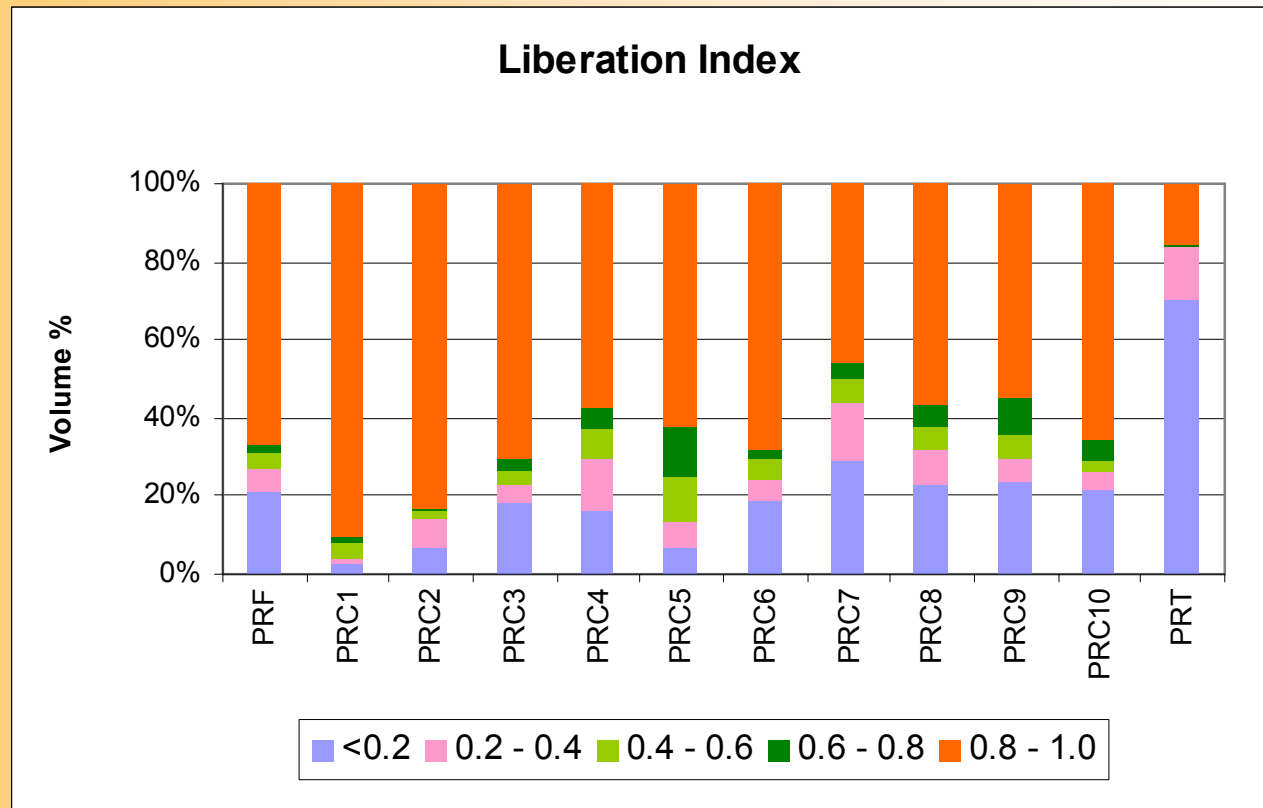
G = Locked PGM

Mode of occurrence



Mode of occurrence

- Liberation index = Area of the valuable mineral/total area of particle
- Liberated PGM or PGM-BMS particle = 1
- Small, locked PGM-BMS in gangue ~0

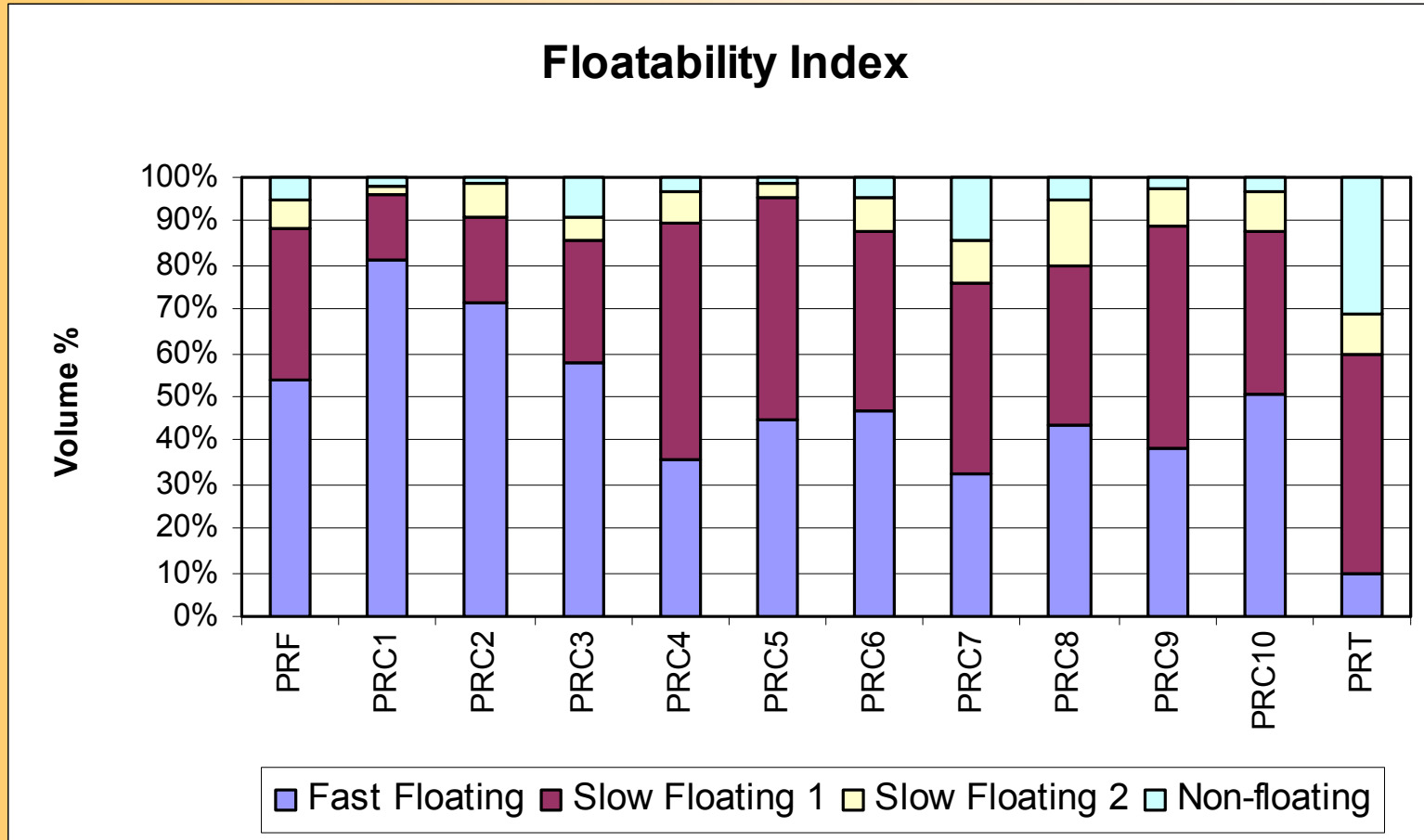


Mode of occurrence

- Floatability index:

Fast Floating	liberated PGMs >3um ECD
	liberated BMS >10um ECD
Slow Floating 1	liberated PGMs <3um ECD
	liberated BMS <10um ECD
	PGMs >3um ECD attached to gangue
	BMS >10um ECD attached to gangue
Slow Floating 2	PGMs <3um ECD attached to gangue
	BMS <10um ECD attached to gangue
Non-floating	PGMs and/or BMS locked in gangue

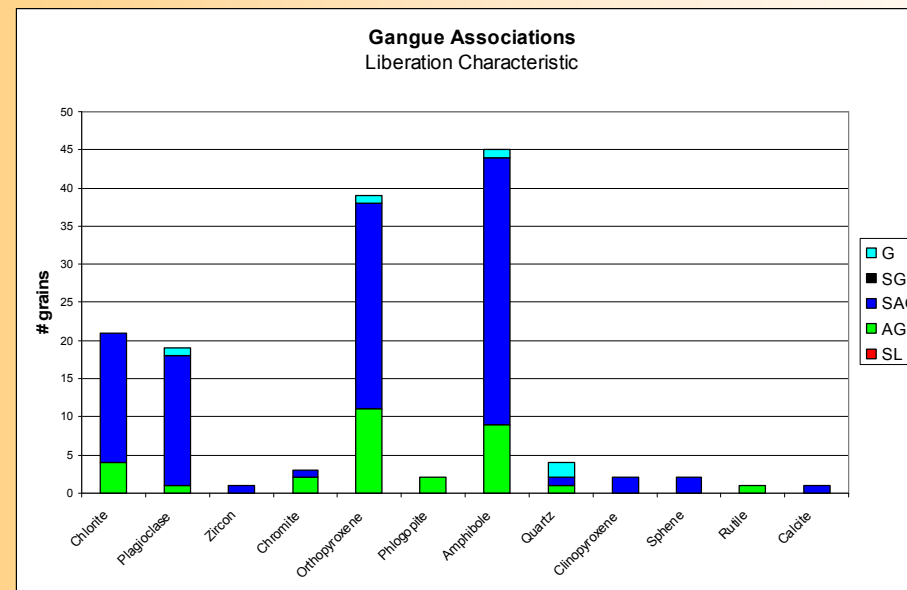
Mode of occurrence



Mode of occurrence

Associated gangue (majority of SAG class):

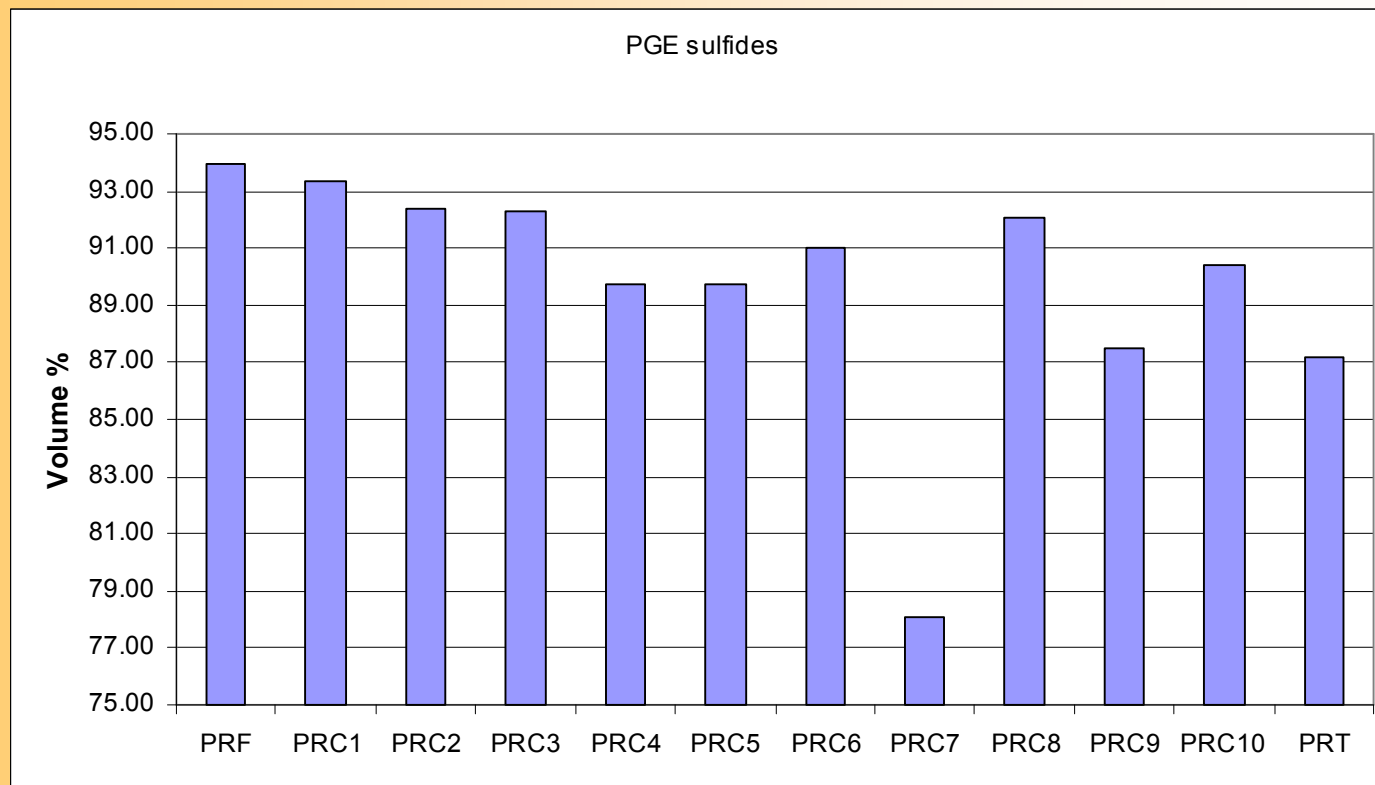
- Orthopyroxene/talc – naturally floatable gangue
- Chlorite – naturally floatable gangue
- Amphibole - ?
- Plagioclase – non-floating (BMS-driven?)



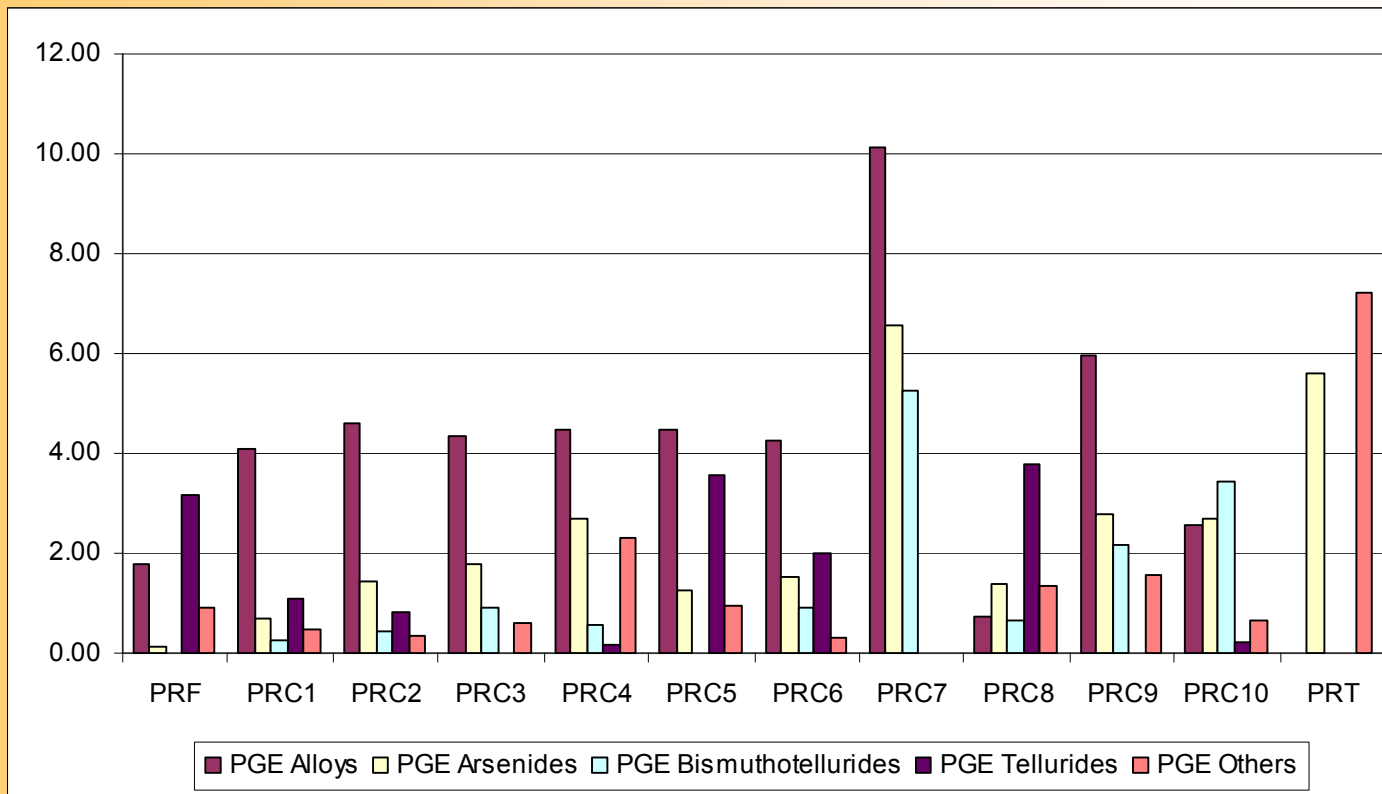
PRC3

Liberated PGMs...

- Smaller data sets



Liberated PGMs...



Preliminary conclusions

- Floatable vs non-floatable gangue; can the floatability index be made more robust by accounting for floatable gangue in a numeric descriptor? Which plant conditions favour such floatability?
- Data are not enough, especially when finer details are sought!
- Is there really a difference expected with such similar grades from PRC 5 to PRC 10?

Acknowledgements

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Thank you



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