A Method for Profiling Magnetic & Gravity Response of Metalliferous Ore Using Data from Mineralogic Mining®

James Strongman[1], Jake Harrison[1], Benjamin Tordoff[2]

[1]Petrolab Ltd., [2]Carl Zeiss Microscopy Ltd.

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Petrolab Limited

- 20 years of consultancy to the mineral processing and mining industries
- Specialist in both mineralogical consultancy and commercial section preparation
- Team of innovative and forward thinking mineralogists, geologists and technicians
- Our core clients are mineral processers and mining consultants – We understand their questions and how to get the answers

Overview

Problem Mineral Processing circuits deal with particles composed of multiple minerals with different chemical & physical properties

"Process particles not minerals"

Method Using Mineralogic mining to map and profile a metallurgical test product and highlight key differences

Results Profiles of the feed and resulting products reveal key data to guide and corroborate test work

Future Focused analysis of the data sets reveals key physical and morphological data to improving recovery

Mineral Processing

- Mineral processors look to identify a distinct difference between target mineral and gangue.

- Four principle separation techniques

- Flotation
- Leaching

Chemical

- Gravity
- Magnetic

Physical

- **Case study selected –** Gravity and Magnetic profiling of a tungsten Ore test product

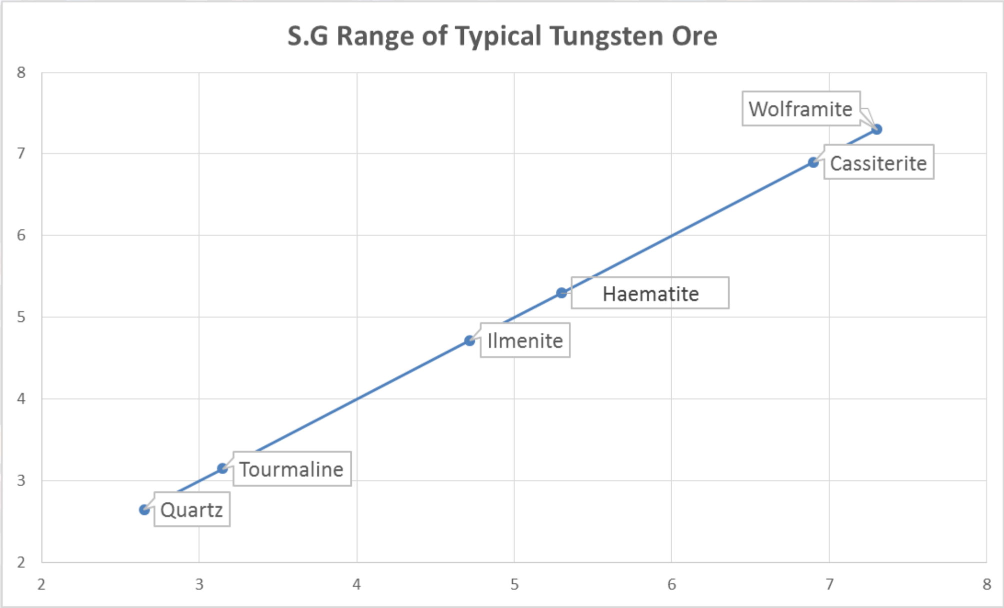
- Study objective – Asses and predict the feed and products response to gravity and magnetic separation

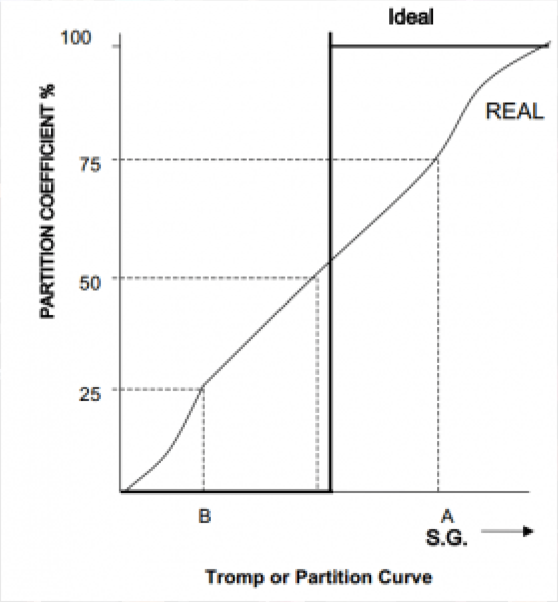
Gravity Separation

- Key physical separator - Density g/cm3

Typical density difference across a tungsten ore would be between 2.65 g/cm^3 Quartz and Wolframite 7.3 g/cm^3

Test program used a Holman 2000 shaking table, capable of splitting on a s.g difference of ~1 g/cm^3



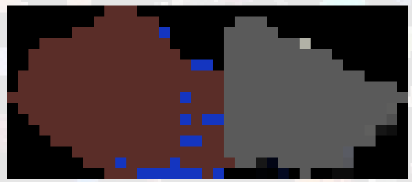


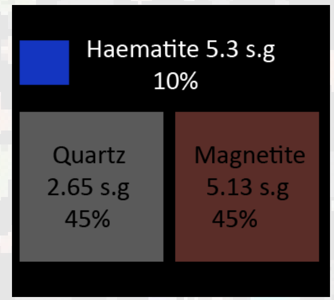
Wills et al 2011

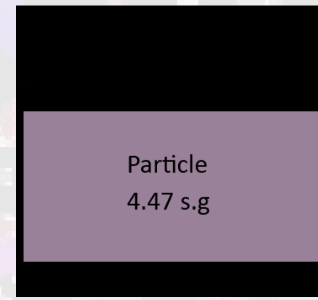
Particles not Minerals

- Particle will respond with combined properties of the contained minerals

Gravity







Analysis Method

Optimisation of microscope conditions, acceleration voltage and brightness/ contrast;

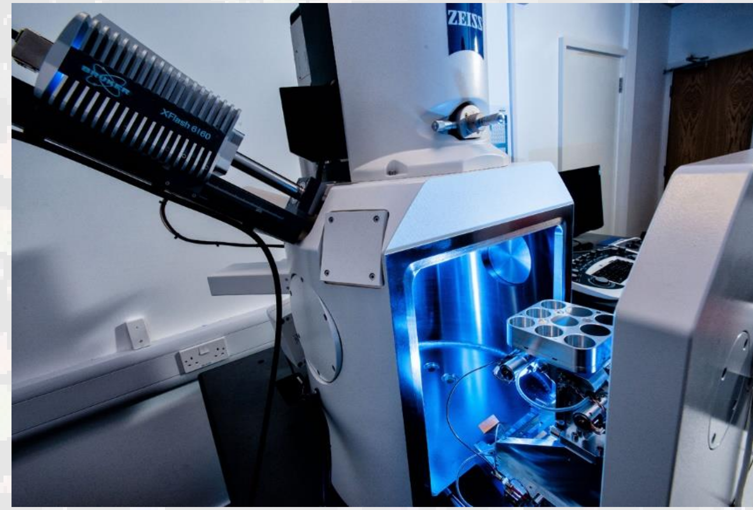
Zeiss EVO MA 25 LaB6-SEM with 60mm^2 X-Flash^N detector 20KV pixel size 5 µm

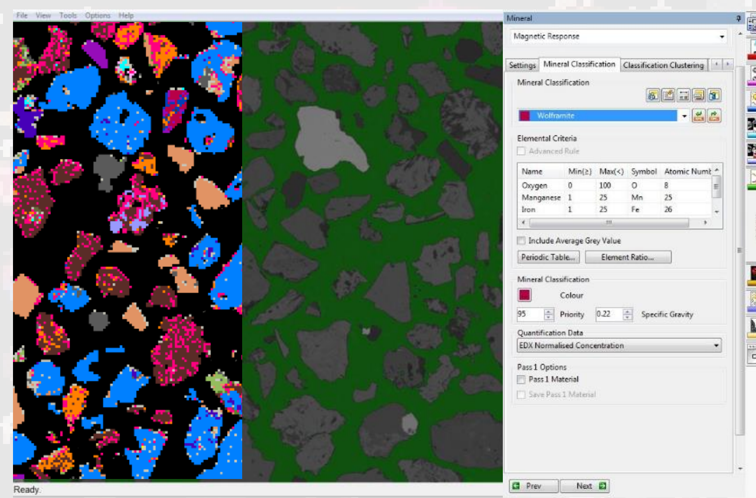
- **BSE Thresholding and Image analysis algorithms**

Define and segregate particles

- **Analysis High resolution BSE image of each particle and EDS data of each pixel**

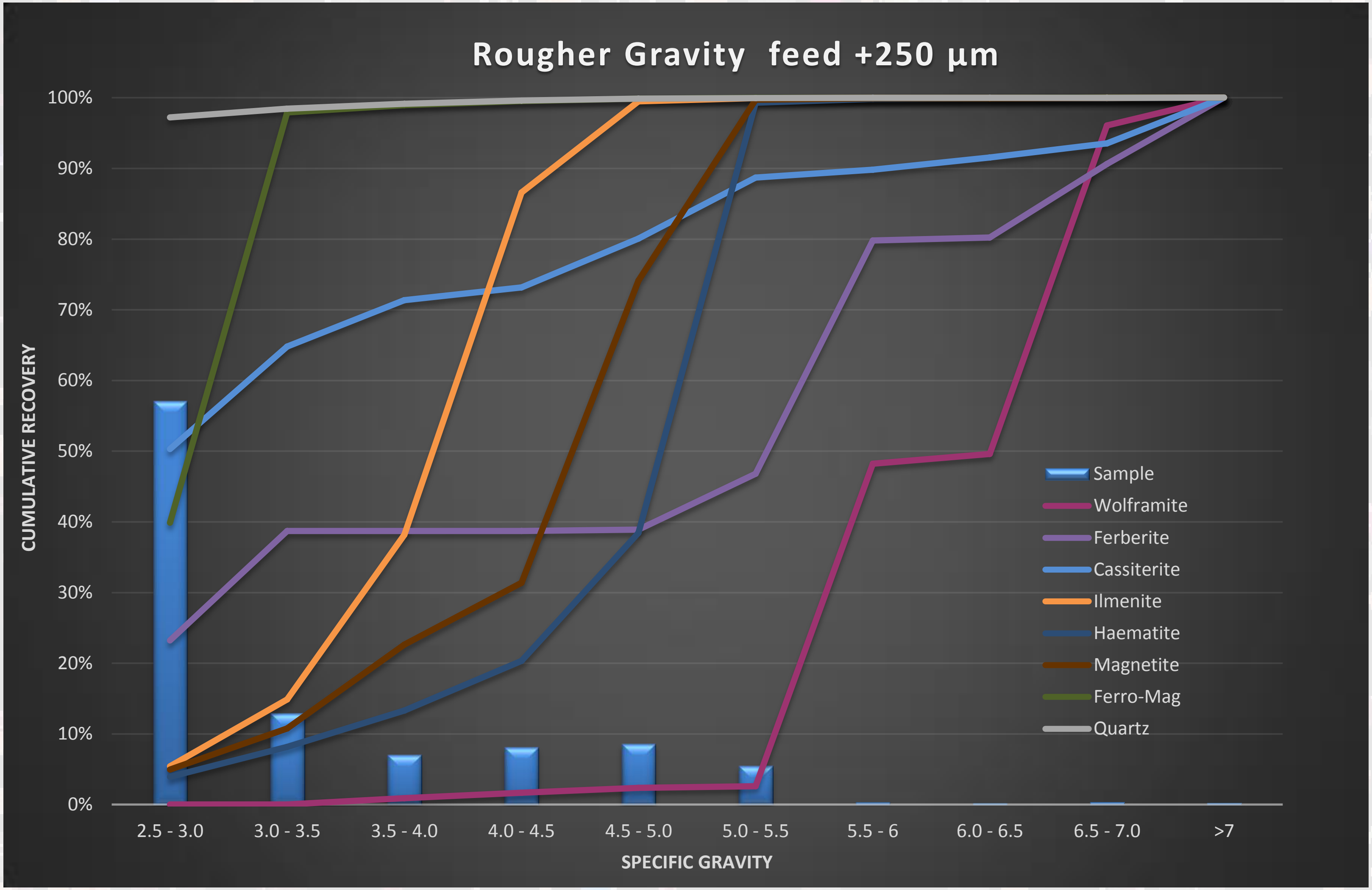
Process time 0.04s (~5,000 counts) per spectra
2k – 5k Particles - runtime 3 hours



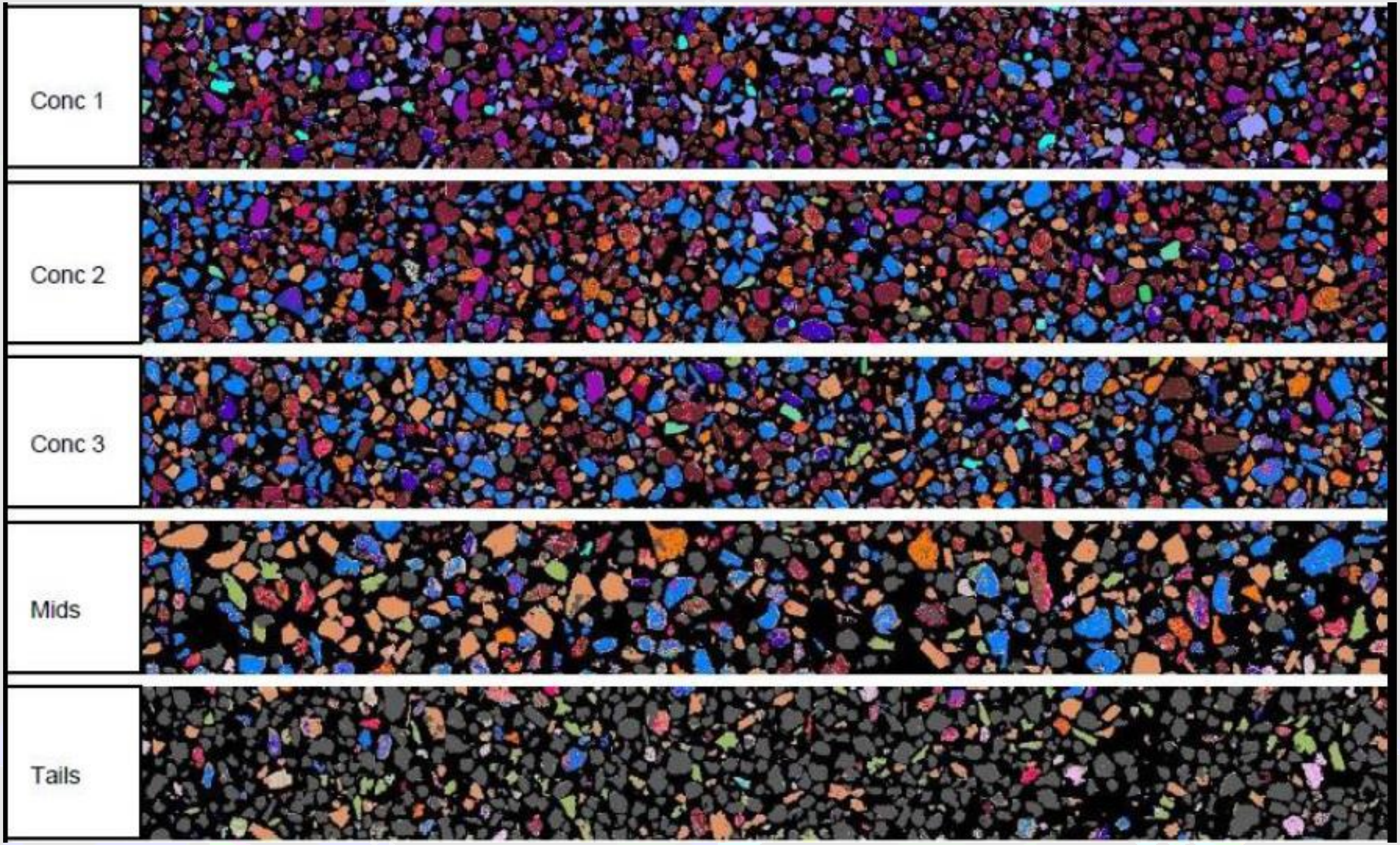


Gravity Results

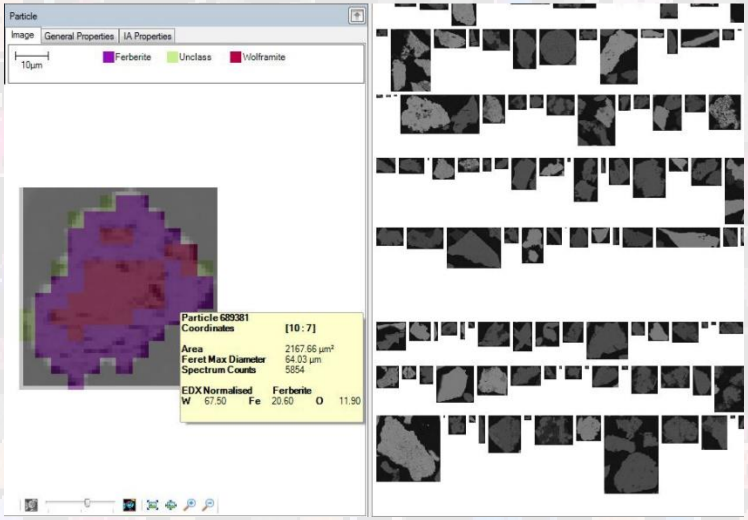
- Feed Profile

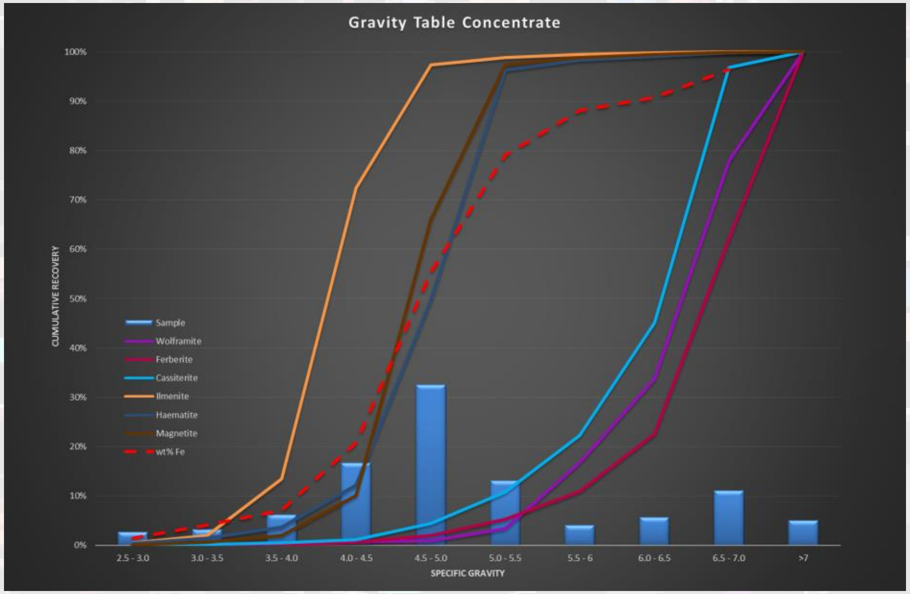


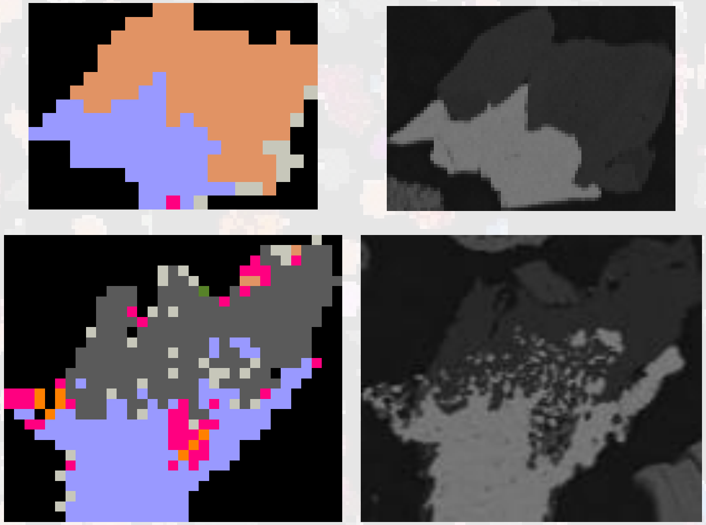
Gravity Results

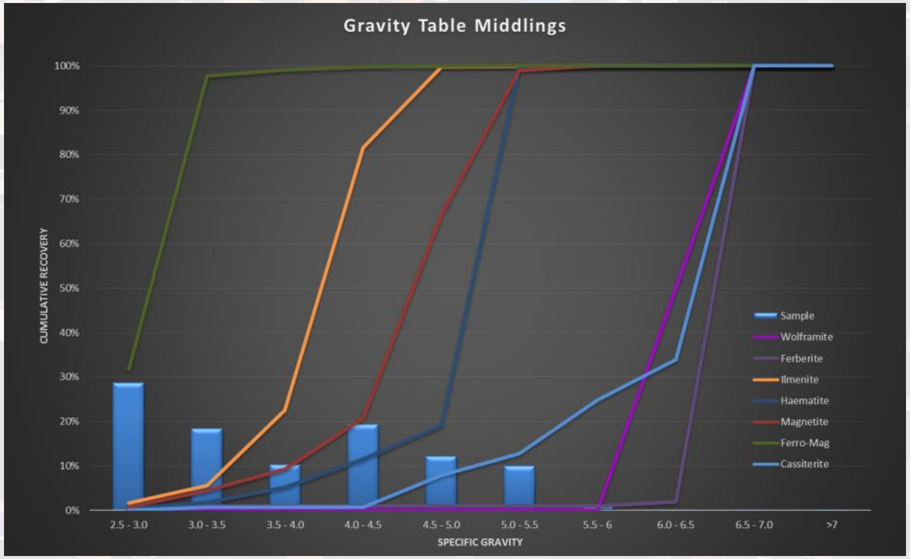


Results Profiles







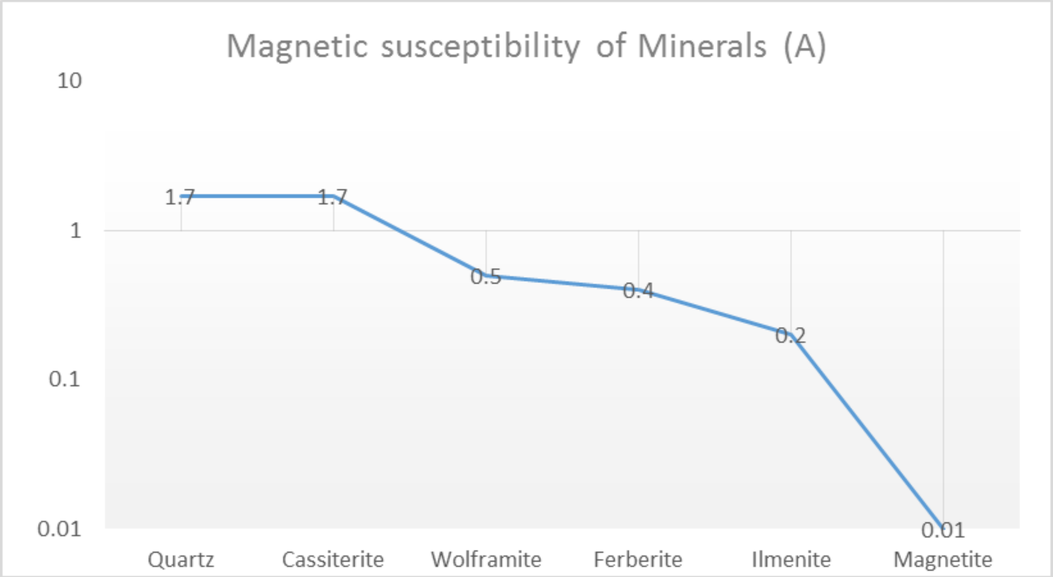


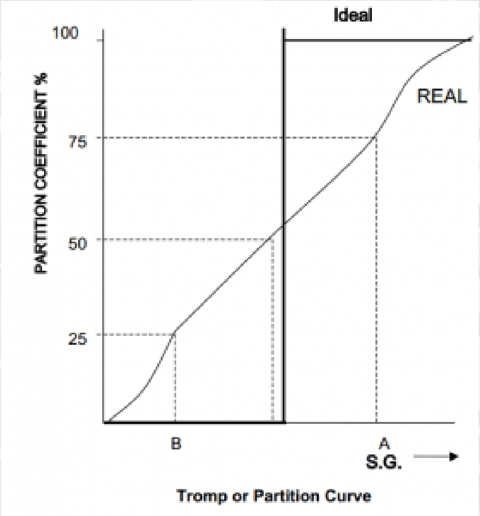
Magnetic Separation

- Key physical separator – Magnetic response

Typical magnetic response of minerals in a tungsten ore can be between Quartz and Magnetite

Test program used a Carpco HIM induced roll separator, which can split differences of magnetic susceptibility ~0.1(A)

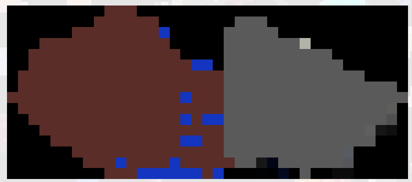


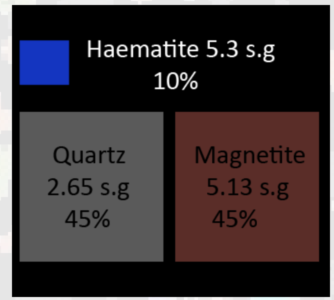


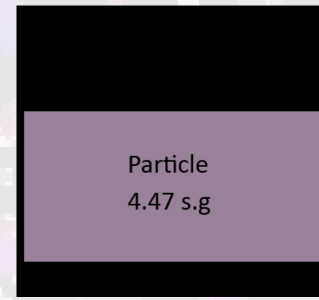
Particles not Minerals

- Particle will respond with combined properties of the contained minerals

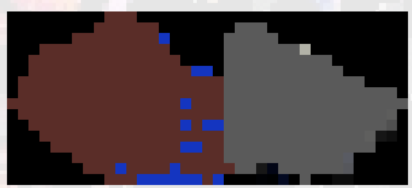
Gravity

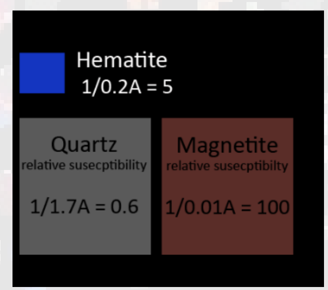


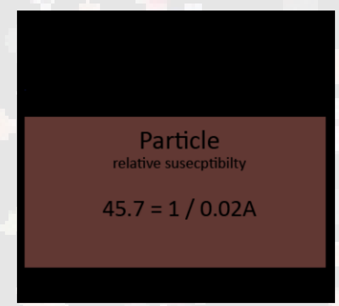




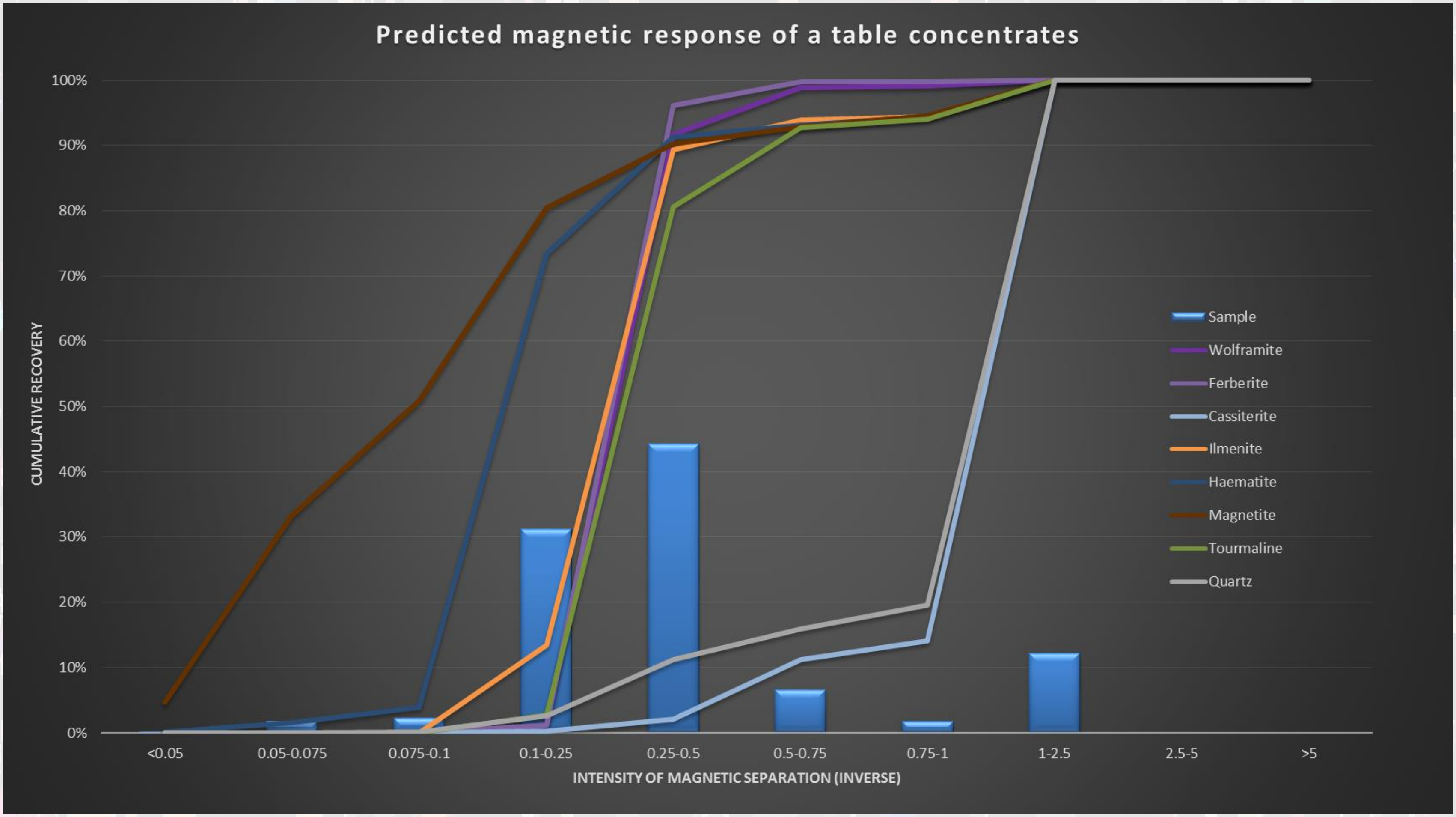
- Electro-magnetic response







Magnetic Profile



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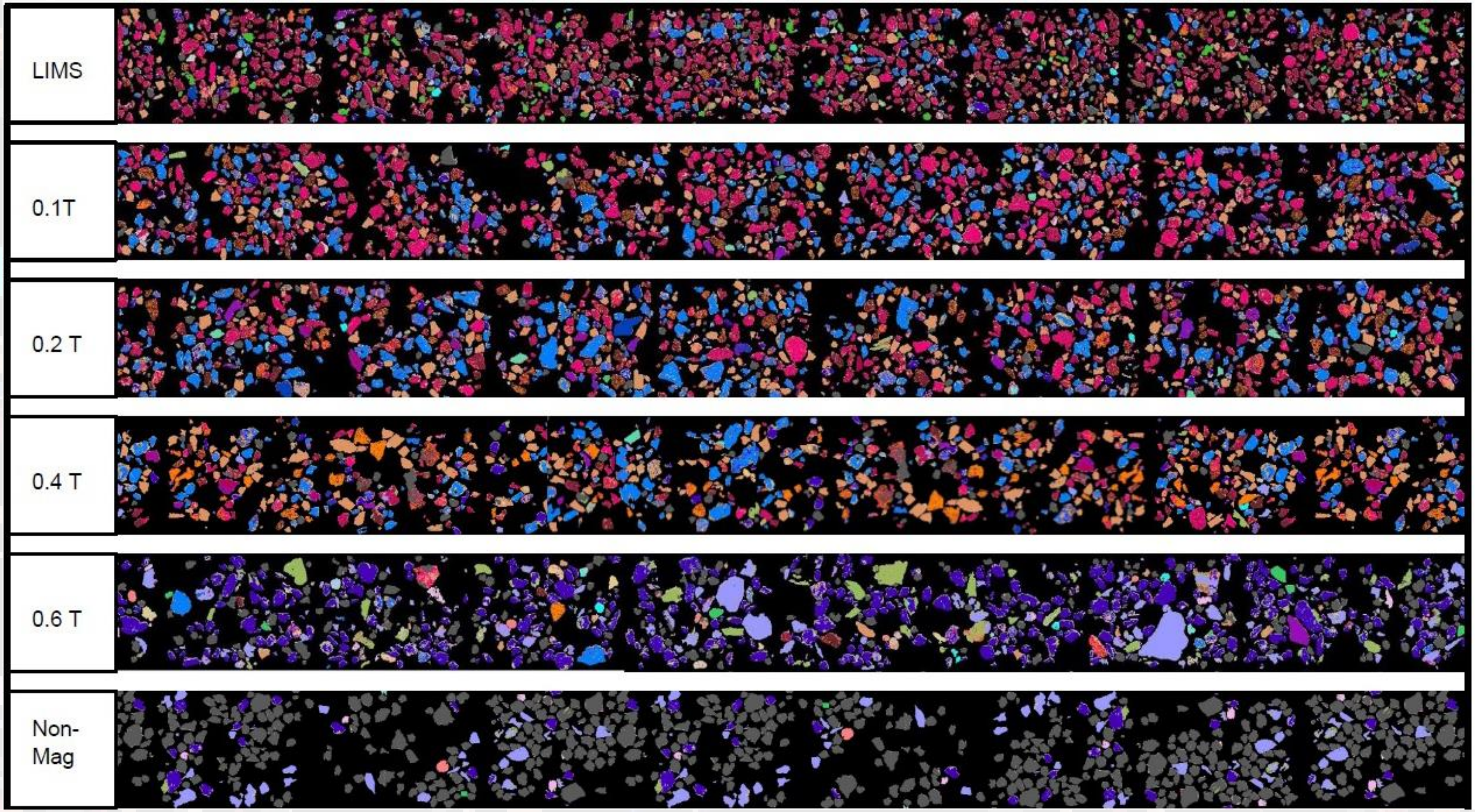
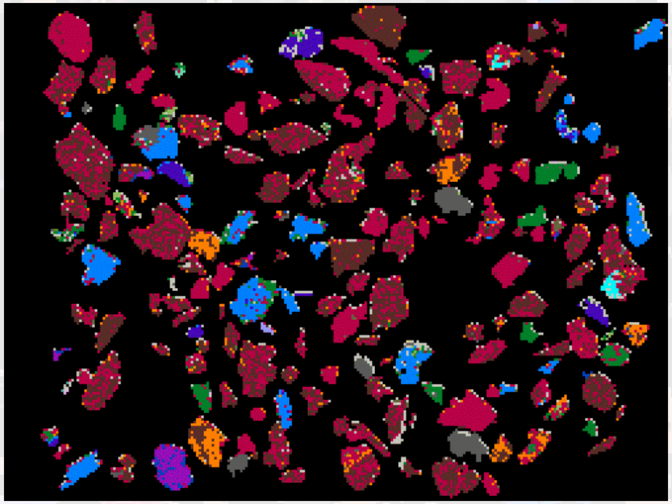
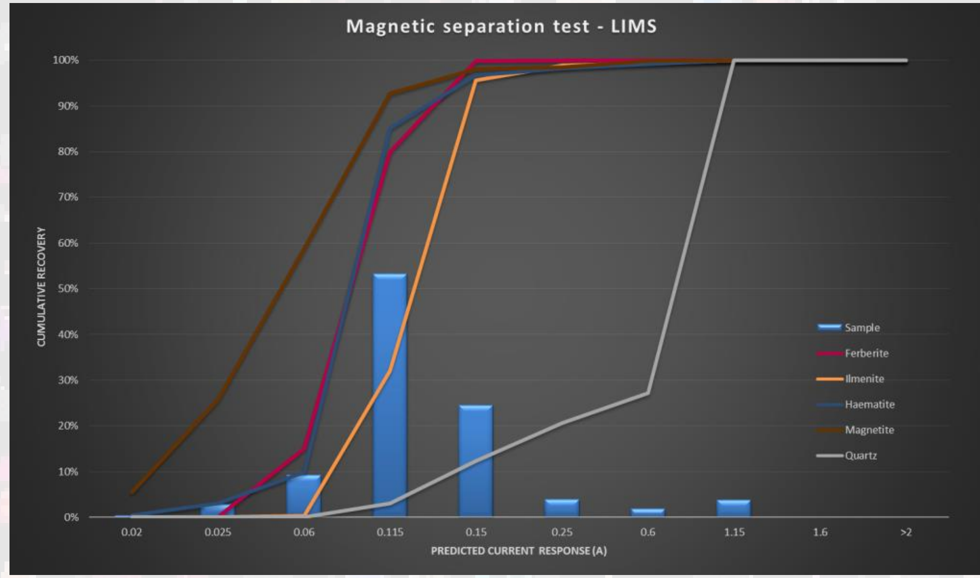
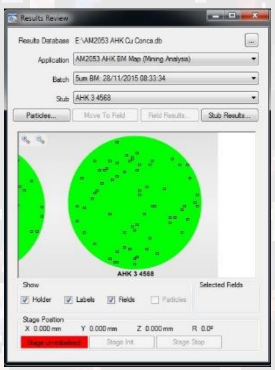
Magnetic Results

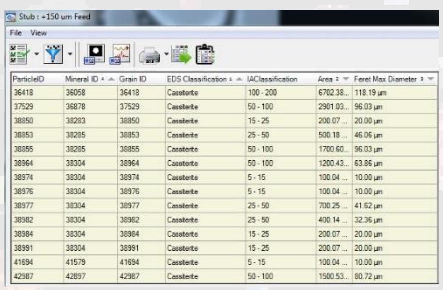


Results

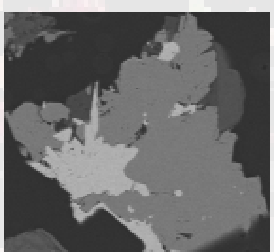


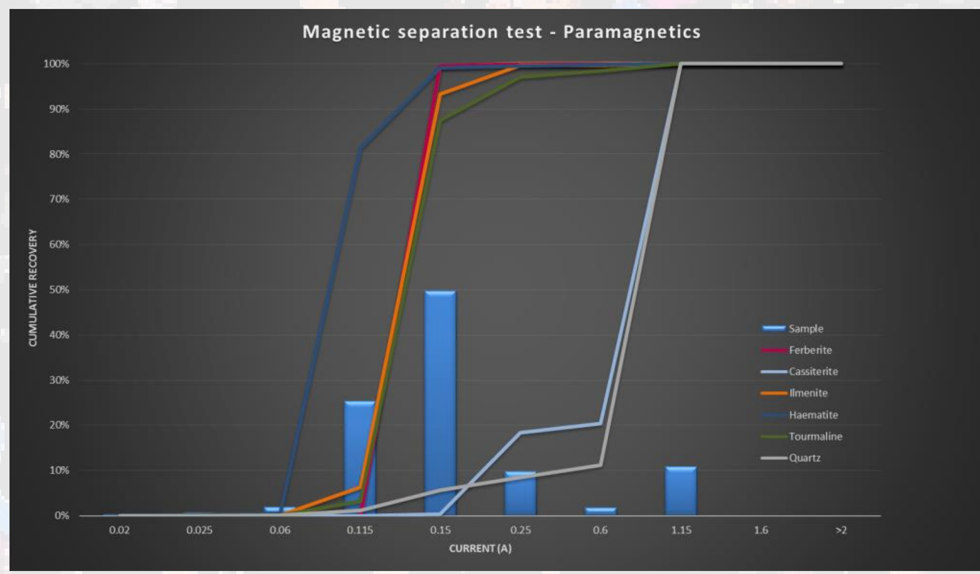






ParticleID	Mineral ID	Grain ID	EDS Classification	IAClassification	Area	Feret Max Diameter
36418	36058	36418	Cassiterite	100 - 200	6702.38...	118.19 µm
37529	36878	37529	Cassiterite	50 - 100	2901.03...	96.03 µm
38850	38283	38850	Cassiterite	15 - 25	200.07 ...	20.00 µm
38853	38285	38853	Cassiterite	25 - 50	500.18 ...	46.06 µm
38855	38285	38855	Cassiterite	50 - 100	1700.60...	96.03 µm
38964	38304	38964	Cassiterite	50 - 100	1200.43...	63.86 µm
38974	38304	38974	Cassiterite	5 - 15	100.04 ...	10.00 µm
38976	38304	38976	Cassiterite	5 - 15	100.04 ...	10.00 µm
38977	38304	38977	Cassiterite	25 - 50	700.25 ...	41.62 µm
38982	38304	38982	Cassiterite	25 - 50	400.14 ...	32.36 µm
38984	38304	38984	Cassiterite	15 - 25	200.07 ...	20.00 µm
38991	38304	38991	Cassiterite	15 - 25	200.07 ...	20.00 µm
41694	41579	41694	Cassiterite	5 - 15	100.04 ...	10.00 µm
42987	42897	42987	Cassiterite	50 - 100	1500.53...	80.72 µm





Summary

- Process particles not minerals, the combined properties of each particle must be considered when predicting how it will respond.

- Profile will show the key separation points and also overlaps.

- Mineralogic is not only provides fully quantitative EDS analysis, but also is based in an MSQL data structure allows detailed integration of the data.

- Study of the particles outside of the predicted response to lead to improved separation.

- Future
    - Routine analysis in operating plants to build trending data sets to optimize circuits against feed mineralogy/ore type.
    - Assignment of probability against particle parameters to build simulation models.
    - Development of the magnetic separation profile by incorporating the effect of density of non-magnetic phases on para-magnetics.

Thank you for your attention

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Robert Fitzpatrick – Cambourne School of Mines

for further information
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