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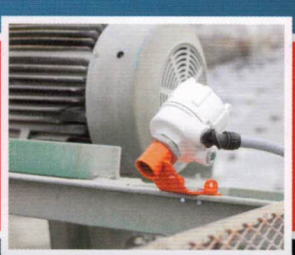
Meaningful process
MINERALOGY

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MEANINGFUL PROCESS MINERALOGY

Simon Isherwood explains why valuable minerals are lost to tails and provides some possible remedies

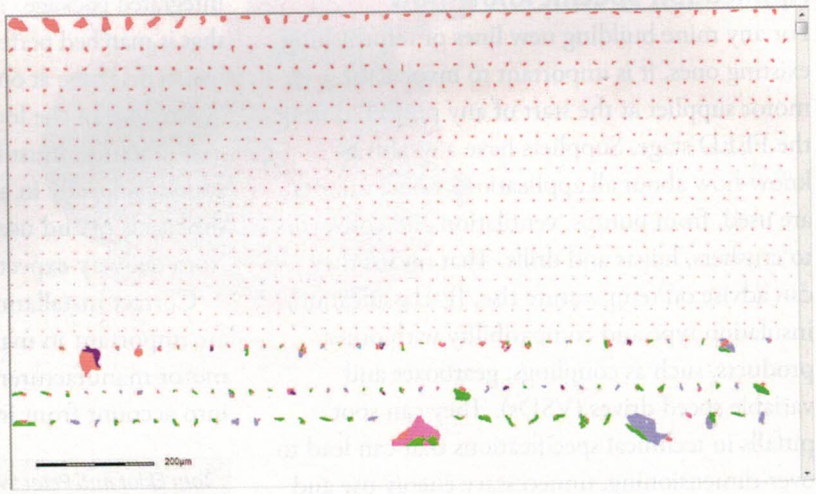
Using automated scanning electron microscopes in mineralogical investigation is not new. What is innovative is how the data can be used to make the mineralogy meaningful to the flotation process. Why are we losing copper, nickel or platinum to tails? This is a familiar question that has provoked discussion since we were able to do elemental analysis. A-SEM data is now regularly used, to identify where value minerals are lost in the flotation process and then to focus the metallurgical problem solving.

Riaan Grobler, manager of the Betachem and Nasaco Process Mineralogy Laboratory, explains: "Offering the right chemical for the application is the basis of what we do. We are regularly sent samples for analysis, by clients and others who are experiencing flotation problems. We scan these on one of our three A-SEM units (MLA from FEI), measure where the losses are, form an opinion of why the losses are occurring and suggest a remedy based on our process experience and reagent know-how."

Here, we will look at the main reasons why mineral values are lost to tailings, explore the reasons, examine some case studies and look at the suggested remedies. The Betachem/Nasaco process mineralogy laboratory in South Africa uses a simple five-point approach in identifying the losses to tails.

- Too fine to float: the Betachem and Nasaco lab normally assumes a cut off size of 10 micron if the process in not operated for fine particle flotation
- Too coarse to float: the lab normally assumes a cut off size of 150 microns in a non-coal flotation circuit
- Locked in non-floating gangue: the lab assumes 80% locking as a locked mineral for most of its projects
- Not the correct process or reagent suite to float a value mineral
- Other reasons, which may include process efficiency

Too fine to float



Chalopyrite (red) particles in final tails

Combined Rougher Scavenger Tails												
Calculated Assay (wt. %)				Mass	Elemental distribution				Summary (wt. %)			
Cu	Ni	Fe	S	Total	Cu	Ni	Fe	S	Too small < 10 micron	Well sized 10 to 212 micron		Too Big >212 micron
										Lib	Not Lib	
0.2	0.0	5.0	2.7	Wt%	%	%	%	%				
Chalcopyrite				0.4	89	0	2	5	49%	34%	16%	1%

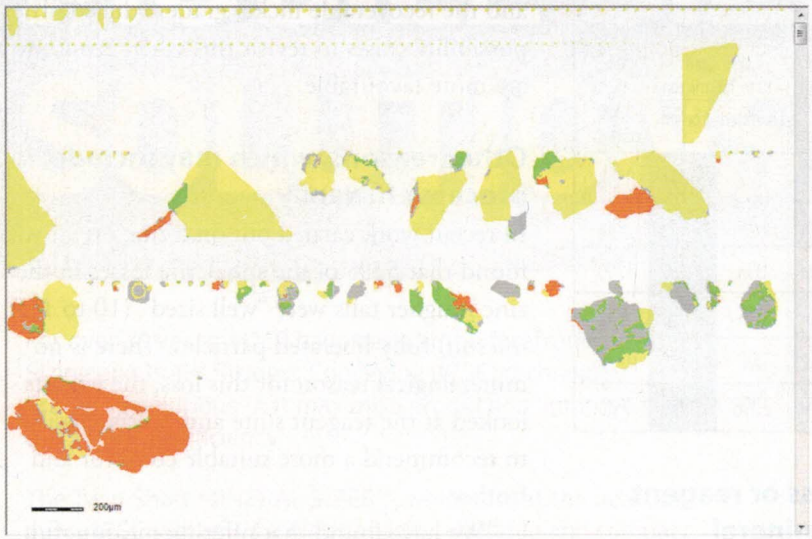
In this copper flotation plant tails, 89% of the copper is lost as chalcopyrite, of which 49% is smaller than 10 micron. The main reason for copper loss is "too fine to float".

This client was advised to:

- Install a flash flotation cell in the milling circuit to capture liberated copper before overgrinding
- Perform a milling and classification survey, recommended addition of water to the cyclone feed and not cyclone overflow
- Reduce pulp viscosity by adding a suitable rheology modifier
- Investigate high-energy flotation cells



Too coarse to float



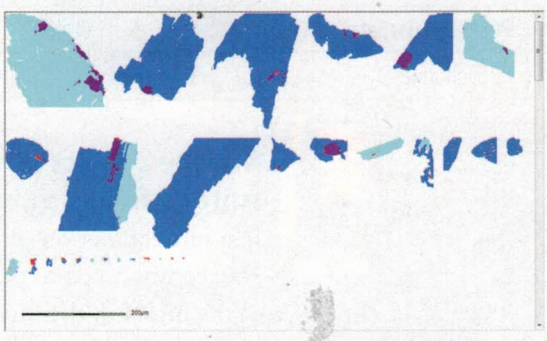
Fluorite (yellow) particles in rougher tails

Rougher Tails												
Calculated Assay (wt. %)				Mass	Elemental distribution				Summary (wt. %)			
F				Total	F				Too small < 10 micron	Well sized 10 to 300 micron		Too Big >300 micron
										Liberated	Locked	
0.97				Wt%	%							
Fluorite				1.98	93				0%	16%	5%	79%

79% of the fluorite in this fluorspar flotation plant is lost as liberated particles larger than 300 microns. The main reason for fluorspar losses in this plant is thus "too coarse to float".

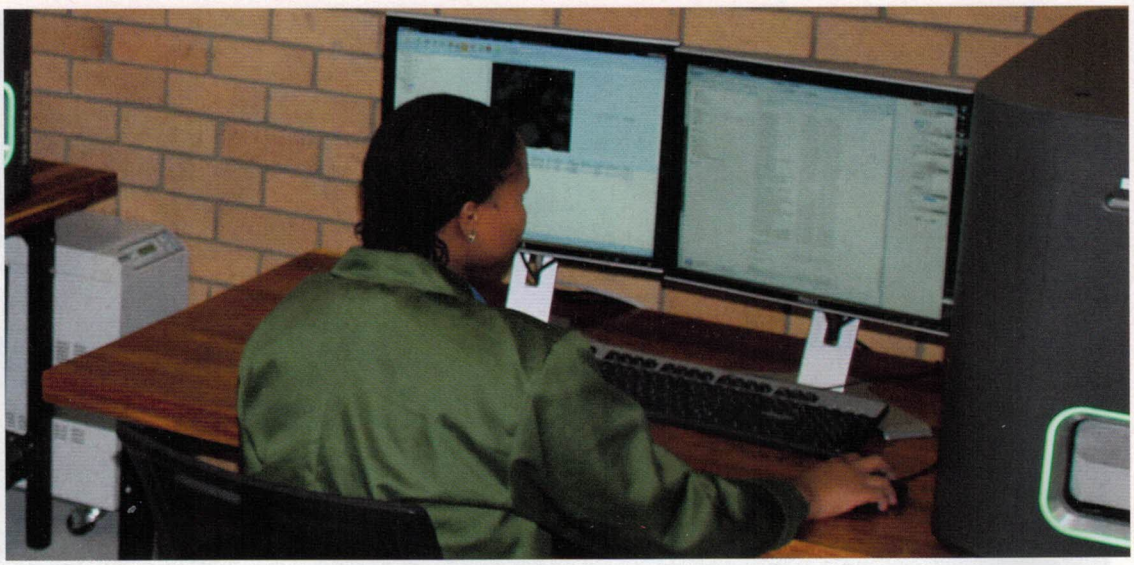
The client was advised to measure and report the plus 300 micron float feed fraction continually. The solution is to improve the milling process and thus flotation.

Locked in non-floating gangue



PGM (red particles) locked in pyroxene (blue)

The platinum group metals (PGMs) in this platinum plant's tailing are mainly present as locked PGMs in the "well sized" (10 to 150 micron) gangue minerals. In this example the locking occurs in pyroxene, which makes up



70% of the feed and is a non-floating gangue mineral. Regrinding the tailings is the typical solution. In this example the pyroxene is also the main gangue mineral in the concentrate and an oxide gangue depressant is used to improve selectivity. Modification of the frother and gangue depressant was advised as the secondary solution.

Final Tails PGMs

Data for the selected bright phase particles only (This is not the total bulk modal mineral composition)	Mass	Elemental distribution				Summary (wt. %)			
	Total	Au	Pt	Pd	Rh	Too small < 10 micron	Well sized 10 to 150 micron		Too Big >300 micron
							Liberated	Locked	
	Wt%	%	%	%	%				
Gold	12.0	100	0	0	0	0%	16%	**17%**	83%
PGE Alloys	30.1	0	11	67	0	43%	37%	**17%**	3%
PGE Sulphides	9.1	0	25	4	0	8%	0%	**75%**	17%
PGE Arsenates	24.6	0	44	3	28	0%	0%	**97%**	3%
PGE Sulpharsenates	3.0	0	3	0	72	0%	0%	**0%**	100%
PGE Tellurides	21.2	0	17	26	0	15%	22%	**56%**	7%

Not the correct process or reagent suite to float a value mineral

In a nickel flotation plant where Betachem/ Nasaco was asked to perform testwork, 35% of the nickel in the final tailing occurred as ultrafine particles in pyrrhotite. MLA analysis showed that the pyrrhotite is mainly well sized and liberated and thus available for recovery by flotation (63% of pyrrhotite reported to the tails). The plant does not use a reagent collector suite to recover the pyrrhotite and this nickel is thus lost. In discussions the possibility of the plant changing to a reagent suite suitable for pyrrhotite recovery was explored. Obviously this would have an effect of increasing the mass pull and load on the cleaning circuit, as more than 5% of the tailings mass is pyrrhotite. The question became: do we increase mass pull by 5.6% and recover the 35% nickel currently lost? The decision was not to recover the pyrrhotite and use a suitable pyrrhotite depressant. The mining plan was adjusted and the recoverable nickel grade reduced. The possibility exists to revisit this when economics are more favourable.

Other reasons, which may include process efficiency

In recent work carried out on a zinc ore, it was found that 53% of the sphalerite losses in the zinc rougher tails were "well sized" (10 to 150 micron) fully liberated particles. There is no mineralogical reason for this loss; the experts looked at the reagent suite and it was possible to recommend a more suitable collector and frother.

"We have found that offering meaningful, process mineralogical data to our clients identifies process problems. It opens a broad discussion in which we solve the problems together - often, but not always, identifying economical, chemical solutions. A core value for us is working with our clients conducting periodic control testing. which allows us to monitor and handle changes," says Grobler. ●

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