Development of Geometallurgical Laboratory Tests to Characterize Metal Preconcentration by Size.

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Presentation Outline

• Mining Productivity Challenges
• Coarse Metal Preconcentration
• Natural Grade by Size metal Deporment definition
• Characterization of natural grade by size deportment
• Sampling campaign spatial related samples
• Conclusions
• Acknowledgments
Mining industry context: Decrease in Productivity

Carrasco, 2014
Resource Depletion (Chile)

~25% Decrease

Energy Consumption increasing (Chile)

~40% Increase

Better ways to extract and process more efficiently ores
Preconcentration at coarse scale (mm)

• Coarse pre-concentration (~10-100 mm) of ROM increase effective feed grades

• This can be achieved using a range of techniques such as: natural grade by size deportment, differential blasting for grade and sensor-based sorting

• Early waste rejection increased productivity on a unit metal basis and facilitates energy efficiency

• This presentation will focus on assessment of natural grade by size Cu deportment
Example Natural Grade by Size Cu deportment

- Feed grade ~ 0.3 % Cu
- 82 % of Cu
- 45 % of Mass
- ~Potential for half the mass and double the grade in screened feed
- Upgrade ~1.8

Natural grade by size response → Preconcentration by size
Natural grade by size as GeoMet attribute

Upgrade versus cumulative weight (%) to describe grade by size response

This response is highly variable

It needs to be embedded into resource model

It determines more amenable zones for preconcentration
Ranking Response for Natural Grade by Size Deportment

Mathematical model is used to describe Natural Grade by Size

Data Base +1000 samples

Response curves are stable across different deposit styles

Ranking Response

Upgrade Metal

Cumulative Weight %

0 20 40 60 80 100

0.5 1 1.5 2 2.5 3

100

10
Application: Bougainville Cu porphyry

In 1987 after extensive testing Bougainville commissioned a screening plant to upgrade low grade ores with a capacity of 35 Mt p.a. (2000 tph) using a screening size of <32mm

<table>
<thead>
<tr>
<th>1999 Annual report</th>
<th>Reserves</th>
<th>Cu%</th>
<th>Au ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low grade as mined</td>
<td>520 Mt</td>
<td>0.22</td>
<td>0.18</td>
</tr>
<tr>
<td>Screened low grade product</td>
<td>195 Mt</td>
<td>0.34</td>
<td>0.28</td>
</tr>
<tr>
<td>Upgrade Factors</td>
<td>38% mass</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Direct feed</td>
<td>496 Mt</td>
<td>0.45</td>
<td>0.55</td>
</tr>
</tbody>
</table>

Burns and Grimes 1984
Not all the material is sent to "preconcentration plant".

Different grade by size response for different rock types

Bougainville Preconcentration Plant

Burns and Grimes 1984
Case of Study of Natural Grade by Size Cu Deportment

- Major Au-Cu Australian Operations.
- Belt Cut Sampling Campaign SAG feed.
- Au and Cu show strong Grade by Size Deportment.
- Response Highly Variable
- Development of GeoMet Tests for Characterisation
Natural Grade by Size Cu Deportment Belt Cuts

Cumulative Weight %

Cumulative Weight %

Cu Upgrade

Samples Covering Dynamic Range
P50~ 50 mm

Ranking Cu Response

XXVII International Mineral Processing Congress
Probability plots are useful to identify extent of variability and populations.
Development of GeoMet Tests for Grade by Size

- Rapid, simple and relatively low cost
- Use of drilling products
- Recognise, rank and predict
- Must apply geometallurgical domaining methods
Blast hole samples

Variability Cu grade by size deportment is depicted within blast hole data

Probability plot suggests three distinctive populations

Production response is consistently higher
Drill core samples crushing protocol

Controlled crushing to obtain 100% -6#

Set of sieves need to be carefully selected

Drill core

Jaw crusher

Sieve 3.35 mm

Coarse Fraction

Fine Fraction

Sieve -3.35 mm

> 10% Total weight?

Yes

No

Roll crusher
Drill core samples

Probability plot suggests three distinctive populations
Comparative Grade by Size Cu Deportment at Different Scales
Grade by size production responses are consistently higher than drilling products.

Drill core and blast hole depict similar responses.
Spatially Related Samples. Bulk sampling Testing

Validate “Scale up Factors”

Bench View
Coherent Cu grade by size blast hole spatial distribution

Cumulative Weight %

Upgrade Cu

B Group Blast hole Sample
C Group Blast hole Sample

High

SF SP2 -180(1)
SF SP2 -180(2)

Low
Natural Cu Grade by size Bulk-blast hole-drill core

Upgrade Cu factors

- SFSP2 180(1) 1.6
- Drill core response 1.3
- Blast hole response 1.2

Cumulative Weight %

Upgrade Cu

Cumulative Weight %

0 10 20 30 40 50 60 70 80 90 100

0.5 1.0 1.5 2.0 2.5 3.0 3.5
Conclusions

• Preferential grade by size Cu deportment can be identified using drilling products

• Variability on grade by size Cu response at drilling scale shows the same dynamic range than production scale

• Response at drilling scale is consistently lower than response measured belt cut and bulk sample

• Blast hole samples can potentially be used to populate preconcentration response at short term

• Further work is required to understand economic impact
Final Thoughts

10 years ago?

Maslow’s new hierarchy of needs

Mining Industry needs to innovate to remain competitive
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