Geometallurgical characterisation of Complex Orebodies: Comminution proxies using hyperspectral imaging and multi-element geochemistry

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Outline

• Introduction and context
• Research Project
• Case Study: Nueva Union
Risks challenge the accessibility to undeveloped copper ore bodies (Valenta et al., 2019).

‘The risks associated with mining are varied and complex, where the dominant source of risk is the orebody itself’ (Annels and Dominy, 2003).

Introduction and context

- Increasing demand for metals
- Decline in discovery rates
- Low grades of ore deposits

Increase in the amount of processed material and augmented impact in terms of costs and environmental footprint (Prior et al., 2012)

Technical challenges of orebody variability and minerals processing

Geometallurgy is considered as a tool to manage risk
Introduction and context

Geometallurgy

Variability of processing behaviour
Prediction of metallurgical performance
Risk reduction

Metallurgical test work
Geological variability
Geometallurgical 3D model

Metallurgical test work
Small-scale test for ore body variability

Introduction and context
Geometallurgy

Metallurgical test work
Geological variability
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Small-scale test for ore body variability
Introduction and context

Geometallurgy

Early projects

- Restricted access to samples
- Proxies
- Risk control
**Introduction and context**

**Geometallurgy**

**Ore body heterogeneity**

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**Large Scale Deposits**

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**Low Grade**

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### Year 2000

**Average Copper Grade**

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Copper Grade</td>
<td>1.5%</td>
<td>0.5%</td>
</tr>
</tbody>
</table>
Porphyry Copper Deposits are the world’s major source of copper (Mudd et al., 2013).

Their low-grade character relevant from a mining and minerals processing perspective.
• Comminution is the most energy-intensive stage in a mine

• Metallurgists select the comminution devices using laboratory and pilot scale tests

  Application of HPGR (High Pressure Grinding Rolls) is limited in metal mining

• We can consider that the composition of the rock can control the breakage…

Average energy consumption by comminution among 46 copper and gold mines in Australia (Ballantyne et al., 2012).
Geological variability
- Textural
- Mineralogical

Lithogeochemistry  
Mineral Quantification  
Hyperspectral imaging  
Texture Analysis
The **aim of the research** is to integrate, at an early stage of a project, mineralogical and textural characteristics of a deposit that can be used to predict comminution performance.

The **main objective** is the development of a fully integrated mineralogical and textural model to produce geometallurgical proxies of performance for the HPGR comminution stage in a porphyry Cu-Au deposit.
1. Characterisation of ore variability

Mineralogical and textural database

+ Comminution index

2. Linking geology and breakage

Prediction of comminution index

3. Extrapolation of comminution proxies to the deposit

Methodology

Research Project
Small-scale test for comminution response in HPGR

Geochemistry Spectral features Image Analysis

Metallurgical Sample
Geological Sample
Complex Orebodies

- Low grade
- Technical challenges
- Political unrest
- Social outrage
- Environmental barriers

Nueva Unión
Proposed infrastructure to support the separate Relincho and El Morro projects

Proposed infrastructure to support the combined NuevaUnión project

# Nueva Union

## Project Name

| Copper (eq) | 0.48 |
| Cu tonnes  | 13,908.255 |

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### Map of Nueva Union

The map shows the location of Nueva Union within the context of its surroundings in Chile and Argentina. Key locations marked include:

- **Pacific Ocean**
- **Relincho**
- **El Morro**
- **Huasco**
- **Freirina**
- **Vallenar**
- **Alto del Carmen**

Distances indicated are:

- 25 km
- 60 km
- 40 km

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### Complex Orebodies | November 05, 2019
La Fortuna Porphyry Cu-Au deposit, NuevaUnion Project

- 650 km N of Santiago, 4100 masl., Atacama Region, Chile
Eocene-Oligocene metallogenic belt (\(\sim 43 - 31\) m.y.)

Measured and indicated mineral resource of 676 Mt at 0.49% Cu and 0.45 g/t Au (Lambert et al., 2012).
Sustainability Contribution

Control risk associated to ore variability
Supply of metals

Geometallurgy for compression breakage
Lower energy usage device
Thank you

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References


