Imaging technologies to understand grinding at particle scale in a UG-2 platinum ore processing plant

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Motivation, means and objectives

Magotteaux Research program for ball milling optimisation
- Slurry position → Sensomag
- Particle analysis → Occhio FC

Case study:
UG-2 Platinum Ore (RSA)

UG-2 mineralization
- ~ 85% chromite
- ~ 15% silicates
- <0.1% BMS

Sampling campaign:
14 surveys
A cut each 10' → one hour composites
Particle Image analysis

- High resolution camera
- Several thousands of particles measured in a few minutes
- High reproducibility of measurement
Particle Image analysis

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- Several thousands of particles measured in a few minutes
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Correlation for >106µm particles

\[ f(x) = 1.28x - 0.08 \]
\[ R^2 = 0.93 \]
Chromite distribution analysis

In-out analysis for each survey \( i \)

\[
\text{Accumulation}_i = \frac{\%\text{Cr}_{(DU,i)} - \%\text{Cr}_{(MD,i)}}{\%\text{Cr}_{(DU,i)}}
\]

Forces applying on particles
- Hydraulic forces
- Mechanical forces

\[ R^2 = 0.83 \]

- Slurry per cent solid

- >106 µm
- <38 µm
- Head grade
Chromite grade and PSD analysis

In-out analysis for each survey $i$

$$\text{Accumulation}_i = \left[ \frac{\%\text{Cr}_{(DU,i)} - \%\text{Cr}_{(MD,i)}}{\%\text{Cr}_{(DU,i)}} \right]$$

Forces applying on particles
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Forces applying on particles:
- Hydraulic forces
- Mechanical forces

Slurry per cent solid

Acc. slurry per cent solid

$R^2 = 0.83$

$R^2 = 0.85$
Chromite grade and PSD analysis

In-out analysis for each survey \( i \)

\[
\text{Accumulation}_i = \frac{\%\text{Cr}_{(DU,i)} - \%\text{Cr}_{(MD,i)}}{\%\text{Cr}_{(DU,i)}}
\]

Forces applying on particles
- Hydraulic forces
- Mechanical forces

\( >106 \, \mu m \)  \( <38 \, \mu m \)  head grade

\( \text{R}^2 = 0.85 \)

\( \text{R}^2 = 0.83 \)

\( \text{R}^2 = 0.7 \)

slurry per cent solid
Chromite grade and PSD analysis

In-out analysis for each survey $i$

$$\text{Accumulation}_{i} = \left[ \frac{\%\text{Cr}_{(DU,i)} - \%\text{Cr}_{(MD,i)}}{\%\text{Cr}_{(DU,i)}} \right]$$

Forces applying on particles
- Hydraulic forces
- Mechanical forces

Chromite distribution

Slurry per cent solid

Accumulation vs. slurry per cent solid

$R^2 = 0.85$

$R^2 = 0.83$

$R^2 = 0.7$
Conclusions

Research outcomes

- Particle-based analysis is necessary to deeply understand ball milling
- Low slurry density increase coarse chromite residence time and thus fine chromite formation
- In a UG2 processing plant: PSD and chromite content can be monitored with image analysis

To do

- develop methods to identify more minerals