Optimised waste management using technology

Оптимизирано управление на отпадъци чрез използване на технология

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Waste management optimisation
Оптимизация на управлението на отпадъците

Optimisation means:

• Reduction in waste volumes and maximisation of ore volumes

• Reduction in the life of mine risk profile with respect to environmental liabilities such as acid and metalliferous drainage (AMD)

• Demonstration of sustainability of project over life of mine (LOM)

• Reduction in costs of waste management

Key themes:

• Smart mining: using technology

• Sustainable mining: holistic approach to demonstrate life of mine planning approach

• Efficient mining: approach that reflects true life of mine costs
Current best practice waste management
Съвременни най-добри практики за управление на отпадъците

Key assumption is that what is in the block model reflects what is mined. Grade control important to validate waste plan but also need to consider fragmentation.

Mine waste using same principal as for ore
Assessment of cut off grade (COG): Ore or waste? Оценка на параметри за класификация: руда или отпадък?

Grade (mg/kg Ni, Cu, Zn etc)

Marginal material can be viewed as “high grade waste” or “low grade ore”

• Waste is often given zero value in the mine model and mine plan however high risk waste has a strongly negative value due to significant future liability costs/risks of storage.
• Management of acid mine drainage risk from “marginal material” can easily cost $10 million+ due to requirement for long term water treatment, cover systems or impact mitigation
Well known that particle size (controlled by blasting) influences geochemical and geotechnical properties

- Sulfides, metals and carbonates often concentrate into fine fraction after blasting (e.g. vein systems) meaning fines have different properties than the assumed bulk waste properties

- Fine fraction of waste accounts for perhaps >90% of all acid mine drainage (AMD) load because reaction rate linked to grain size due to surface area, but may be <20% volume

BUT: Standard waste classification and management does not account for particle size: Therefore typical waste management plans involve inadvertently mixing large volume of low grade/risk material with small volumes of high risk/grade material.

- Missed opportunity for optimisation of waste management
- Missed opportunity for metals recovery
Many automated solutions have been developed that allow real time assessment of fragmentation for example FRAG-Track™.
Fragmentation during blasting
Фрагментация по време на взривяване

Block model based on “grade weighted average” for each block

Sulfide $x = 0.3\%$

After blasting sulfides can disintegrate and report to fine fraction. Risk can be underestimated based on block model.
Compositional variation with grain size post blast

Вариация на състава според размер на зърното след взривяване

Fragmentation profile from blasting dictates both the particle size of the waste product and the degree to which concentration of minerals may occur within the fine fraction.

- Coarser particle size < surface area
- Finer particle size > surface area

Concentration of sulfides relative to calcium by grain size indicates that acid generation profile depends on particle size.

- Coarser particles < AMD risk
- Finer particles > AMD risk
Variable distribution of metal grade by grain size indicates that “bulk” material properties as defined in block models and test on drill core may not represent the “as mined” product.

- Pentlandite and Chalcopyrite concentrated in the fines:
  - Finer fraction of “waste” is potentially ore grade material
  - Finer fraction also has higher AMD risk
Waste rock components

>22mm

• >60% volume
• <10% surface area
• Metal content < average block value
• Sulfide content < average block value

Low environmental liability and low metal recovery potential

<22mm

• <40% volume
• >90% surface area
• Metal content > average block value
• Sulfide content > average block value

High environmental liability and management cost but also high metal recovery potential
Implications of fragmentation on the management of waste rock

- Oxygen contact with high risk material enhanced where placement of fines with coarse material occurs. End tipping causes segregation which enhances this process. Oxygen is the “fuel” driving AMD.

- The “encapsulation” of high risk material in end tipped dump often does not reduce oxygen flux risk. High risk solution.

- The placement of a “final cover” across entire dump to manage risks caused by inefficient waste placement should be considered last resort: “mitigation” not “prevention.”

Typical waste placement: Mixing small volumes of high risk fines (possibly ore grade) with low risk coarse materials.

Water treatment as a result of AMD in seepage should be considered last resort: “mitigation” not “prevention.”
Opportunities to optimise waste management
Възможности за оптимизиране на управлението на отпадъците

- **Identifying waste and ore:** Grade control drilling and fragmentation analysis provides key data for optimal mining of waste and recovery of ore

- **Recovering ore from waste:** Fines with metal content >COG may be recovered by simple screening. Possible to use grade control data and fragmentation assessment to identify target zones for ore recovery. Mill throughput may be optimised as a result of being able to bypass crushing steps.

- **Reduce volume of high risk material:** Removal of >80% of AMD risk by screening out 10-20% of the volume. Focus AMD management on smaller volume of true high risk material more cost effective and lower risk than treating all material as same risk

- **Reduce requirement for large scale engineering:** If high risk materials are removed, or focused into smaller areas, then removes requirement for “whole of dump” solution such as placement of cover systems over entire waste rock dump surfaces.

- **Manufacture rehabilitation materials:** Materials for rehabilitation and AMD management such as advection barriers, cover systems, growth medium etc require PSD of certain grade. Possible to use fragmentation assessment and blast optimisation in targeted zones i.e. blast useable material to required size.
Optimised waste management using screening: demonstrating sustainable mining practice

Optимизирано управление на отпадъците с изплозване на скрининг: демонстриране на устойчиви минни практики

Fines direct to mill: bypass primary/secondary crushing

Low risk coarse material to waste dump: Reduced management required

Use data as grade control inputs to optimise mining model, blasting pattern and LOM waste schedule
X-ray microscopy (XRM)
Рентгенована микроскопия

- Can complete detailed 3D scans of drill core/rock samples to determine distribution of sulfides during exploration phase.
- Data can be used to determine likelihood that minerals may preferentially report to fine/coarse fraction after blasting.
- Very important when determining:
  - AMD risk
  - Metal recovery potential
- Assessment can be linked with physical testing (PLI) to determine likely fragmentation profile during feasibly stage assessments.
Thankyou
Благодаря

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