Reprocessing of mineral processing waste: an overview

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In collaboration with

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The French Geological Survey

The BRGM is France’s leading public institution working in earth science applications for the management of surface and subsurface resources and risks.

Its activities are geared to scientific research, support to public policy development and international cooperation.

Over 1000 staff including more than 700 engineers and researchers.

www.BRGM.EU
Mining waste: materials that result from the exploration, mining and processing of substances governed by legislation on mines and quarries

- Top soil, overburden, waste rock (unused extraction product)
- Tailings & processing wastes (waste finely grounded rocks).
- Metallurgical wastes (from metal production steps)
- Mine effluents (AMD, Mine dewatering, Process waters)
Increasing demand from modern industry for base & “strategic” metals
Minimizing environmental impact of the extractive industry on natural resources
Moving towards a more competitive resource-efficient economy: mining industry is a key actor of a more circular economy by “optimising its processes” and by “recycling its waste” treating them as “by-product”!

Turning waste into a resource is an essential part of increasing resource efficiency and moving towards a more circular economy
Directive 2006/21/EC on the management of waste from the extractive industries (the mining waste directive) + Reference Document on Best Available Techniques for the management of tailings and waste-rock in mining activities

- **Waste Management Plan - Article 5**
  - to prevent or reduce waste production and its harmfulness
  - to encourage the recovery of extractive waste by means of recycling, reusing or reclaiming where this is environmentally sound
  - to ensure short and long-term safe disposal of the extractive waste

- **Inventory of closed waste facilities - Article 20**
  - Inventory of closed waste facilities including abandoned waste facilities which cause serious negative environmental impacts or have the potential of becoming a serious threat to human health

Information on the ongoing review of the MTWR BREF can be found at
Abandoned waste from closed mines or past operations may still contain profitable recoverable commodities

- Market price of commodities increased significantly since mine closure,
- Processing technologies improved significantly since mine closure,
- Presence of associated metals present in the ore and not recovered and thus sent to waste

**Pro**
- Available material avoiding mining and costly pre-treatment steps
- Added value to classical rehabilitation scenario and better management of contaminants
- Limiting AMD/ARD effects

**Con**
- Re-mobilisation of contaminants and pollutants (such as As)
- Often not directly profitable; value of secondary materials?
- Regulation?
- Sand-rich tailings mixed with cement used as backfill in underground mines
- Reprocessing to extract minerals and metals

- DRD Gold, one of the first South African companies to abandon traditional mining to focus on extracting gold from tailings.
- New technology allows it to recover up to 40% of the gold left in particle form in tailings.

From Bernd G. Lottermoser
*ELEMENTS, VOL. 7, PP. 405–410

Kasese Project - The ”ideal” case of reprocessing mining waste (1990 - 2015)

- Kilembe Copper Mine Tailings: an environmental issue; discharge trail from the mine site to the Queen Elisabeth National Park due to runoff and natural bioleaching of a pyrite concentrate Stockpiled (1 M tonnes, 1.4% Co)
From laboratory (BRGM) to industrial scale (KCCL)

10 years

(from Moses Mukwajanga, KCCL)
Promine Project (2009-2013) - From inventory of mining waste to process options

Mining Waste: Convert Resources into Reserves?

1. An Anthropogenic concentrations Data Base for inventoring secondary valuable mining and metallurgical residues (volume and potential remaining metals)

2. Innovation in mineral processing and hydrometallurgical processes needed
Promine Project - Innovation to improve the potential profitability of mining waste treatment - New Bioreactor for Bioleaching application

Flotatton Tailings (sulphides) case study

Patented concept: AG. Guezennec, Y. Menard, D. Morin, P. d’Hugues, Ibarra d., Jaillet M. Pubill Melsio A Savreux F.
Some EU R&D Projects including actions on Mining Waste

Inventory & characterization of wastes

Developing innovative technologies for unlocking the use of potential domestic raw materials (including mining, mineral processing and metallurgical waste):

- Processing methods (and equipment) mainly used on a large scale over the last 100 years are not always appropriate for treatment of mining wastes (M. Battersby, Maelgwyn Mineral Services Ltd – impact conference London 28 March 2017)

- new approaches are required for better mineral liberation, treatment of fine particles, reuse of all remaining materials, optimised downstream options, lower energy and water requirements, smaller footprint, mobility of equipment
Development of a novel biological co-processing approach for the recovery of strategic metals contained in waste PCBs using sulfidic mining wastes as a source of lixiviant.

Coordinator: Dr Chris Bryan, Camborne School of Mines, University of Exeter, UK
Reprocessing of Mining waste - « Business model » ?

1. **Cost for treatment < Revenue from metal / material**
   - Profitable operation
   - Potential limitations (regulation? capital costs? local context? management of pollutants?)

2. **Cost for treatment > Revenue from metal / material**
   If not directly profitable: Other criteria to reprocess?
   - Regulation / Risk: requirement for remediation / mitigation actions (and associated costs)
   - Long term external environmental costs
   - Market value of Land
1. **Inventory / characterisation of « secondary deposits »**
   - Market analysis
   - Opportunities

2. **Proposals for New technical solutions**
   - Better mineral liberation, treatment of fine particles, reuse of all remaining materials, optimised downstream options, lower energy and water requirements, smaller footprint, mobility of equipment ...

3. **New Business model**
   - with integration of LCA approach and cost/benefits of externalities
   - Dialogue and shared effort in between stakeholders (private/public collaboration)
Thank you for your attention

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