Raw Materials recovery from mining and metallurgical residues
Evidence review

Carlo Cormio
Outline

- Introduction
  - MINEA WG 2.1 objectives and achievements
  - Scope of the evidence review
- Evidence Review
  - Method description
  - Results & discussion
- Conclusions
MINEA WG 2.1 objectives and achievements

Objectives

- Develop a common understanding and definitions regarding material resources/reserves in mining residues deposits, both closed and in operation.
- Establish a knowledge base including technologies and data sources for Raw Materials recovery from mining residues.
- Provide inputs to policy makers on the resource potential in mining residues.
MINEA WG 2.1 objectives and achievements

Main achievements

☑ Survey of national mine waste registries from 7 European countries for their potential use as source of information aiming at the valorization of mine waste deposits *

Definition of 33 parameters for valuable materials recoverability assessment.

☑ Collection and review of 66 case studies of Raw Materials recovery projects using mining and metallurgical residues as source of minerals or materials **.

☑ Collaboration with WG4 in the assessment of the classification and reporting of mining and metallurgical residues as resources/reserves

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Introduction

- **Scope of the evidence review**
  - **Assess current knowledge, knowledge gaps and action needed** to foster the production of RMs from mining / metallurgical residues
  - **Analyse case studies providing SITE-SPECIFIC** characterization, evaluation and / or classification for minerals / materials recovery
  - **Screen existing projects** dealing with exploration, characterization, evaluation, processing, impact assessment of mining / metallurgical residues.

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+ T. Werner (University of Melbourne) and the contribution of S. Heuss-Aßbichler and U. Kral
- **Data sources**
  - Technical reports for investors
  - Reports and databases of research projects dealing with production of raw materials from mining/metallurgical residues
  - Reports from international organizations and research centers
  - Scientific papers published in international journals
  - PhD thesis
Evidence review
Method description

Information collected

- **References**
  - Document type (paper/book, presentation, deliverable, specifications, technical report, etc.)
  - Document info (title, authors, geographic coverage, full reference, notes)

- **Case studies**
  - General data (RM source, target materials, location, maturity level)
  - Resource assessment (characterization, evaluation, classification)
  - Stakeholder perspective (funding body, objectives, target audience)

Detailed guidelines prepared to add new case studies / update existing ones
Collaborative tools allowed experts from EU, UK, Australia to collect and review case studies
### General data

#### Raw Material source

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>WR</td>
<td>Waste rocks</td>
</tr>
<tr>
<td>LgS</td>
<td>Low grade stockpiles</td>
</tr>
<tr>
<td>T</td>
<td>Tailings</td>
</tr>
<tr>
<td>M</td>
<td>Metallurgical residues</td>
</tr>
</tbody>
</table>

#### Target materials

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM</td>
<td>Previously mined minerals</td>
</tr>
<tr>
<td>NP</td>
<td>Non previously mined minerals</td>
</tr>
<tr>
<td>NM</td>
<td>New materials</td>
</tr>
</tbody>
</table>

#### Maturity level

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>Research work</td>
</tr>
<tr>
<td>P</td>
<td>Prospect study</td>
</tr>
<tr>
<td>O</td>
<td>Operating</td>
</tr>
</tbody>
</table>
## Resource assessment

### Characterization

<table>
<thead>
<tr>
<th>Key</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>Location</td>
</tr>
<tr>
<td>V</td>
<td>Volumes or masses</td>
</tr>
<tr>
<td>C</td>
<td>Chemical specification</td>
</tr>
<tr>
<td>P</td>
<td>Particle sizes / distribution</td>
</tr>
<tr>
<td>M</td>
<td>Material composition</td>
</tr>
<tr>
<td>W</td>
<td>Water content</td>
</tr>
<tr>
<td>Le</td>
<td>Leachates</td>
</tr>
</tbody>
</table>

### Evaluation

<table>
<thead>
<tr>
<th>Key</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Economic feasibility</td>
</tr>
<tr>
<td>E</td>
<td>Environmental impact</td>
</tr>
<tr>
<td>M</td>
<td>Market acceptance</td>
</tr>
<tr>
<td>S</td>
<td>Socio-political acceptance</td>
</tr>
<tr>
<td>A</td>
<td>Legal accessibility to resource</td>
</tr>
<tr>
<td>T</td>
<td>Technical recoverability</td>
</tr>
<tr>
<td>I</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>L</td>
<td>Legal compliance</td>
</tr>
</tbody>
</table>

### Classification

<table>
<thead>
<tr>
<th>Key Description</th>
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<tbody>
<tr>
<td>-</td>
</tr>
<tr>
<td>NI 43-101</td>
</tr>
<tr>
<td>JORC</td>
</tr>
<tr>
<td>PERC</td>
</tr>
<tr>
<td>SAMREC/SAMVAL</td>
</tr>
<tr>
<td>SME</td>
</tr>
<tr>
<td>CMC</td>
</tr>
<tr>
<td>NAEN</td>
</tr>
<tr>
<td>UNFC</td>
</tr>
<tr>
<td>UNFC-A</td>
</tr>
<tr>
<td>UNFC + PERC</td>
</tr>
<tr>
<td>other (specify)</td>
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</table>
## Stakeholder perspective

<table>
<thead>
<tr>
<th>Funding Body</th>
<th>Description</th>
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<tbody>
<tr>
<td>PA</td>
<td>Public Agency</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>NPO</td>
<td>Non-profit Organization</td>
</tr>
<tr>
<td>MC</td>
<td>Mining company</td>
</tr>
<tr>
<td>PC</td>
<td>Private company</td>
</tr>
<tr>
<td>U/R</td>
<td>University / Research center</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MiR</td>
<td>Mineral recovery</td>
</tr>
<tr>
<td>MaR</td>
<td>Material recovery</td>
</tr>
<tr>
<td>LR</td>
<td>Land recovery</td>
</tr>
<tr>
<td>ER</td>
<td>Environmental remediation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Target audience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key</td>
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<tr>
<td>------</td>
</tr>
<tr>
<td>R</td>
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<tr>
<td>M</td>
</tr>
<tr>
<td>PA</td>
</tr>
</tbody>
</table>
Evidence review
Results & discussion

- Geographical distribution
  - 66 case studies worldwide
  - 14 in Europe (~ 20%)
Evidence review
Results & discussion

Stakeholder perspective

Objectives

- Mineral recovery, Material recovery, Land recovery, Environmental remediation
- Mineral recovery, Material recovery
- Mineral recovery, Land recovery
- Mineral recovery, Environmental remediation
- Land recovery, Environmental remediation
- Material recovery

90% of case studies focus on mineral recovery. Among those:
- 7.5% linked to env. remediation
- 3% linked to land recovery
Evidence review

Results & discussion

Stakeholder perspective

Target audience

Market accounts for ~99 % of audience

Public administrations account for 13.6 %

[Diagram showing distribution of audience]
Evidence review
Results & discussion

- General data

Raw Materials Source

- Metallurgical residues
- Waste Rocks, Low Grade Stockpiles, Tailings
- Waste Rocks, Tailings, Met. Residues
- Waste Rocks, Tailings
- Low grade Stockpiles, Met. Residues
- Low grade Stockpiles
- Tailings

✓ ~ 80% of case studies deal with tailings valorization only
### General data

#### Target material

- **Previously mined, Not previously mined, New Material**
- **Previously mined, Not previously mined**
- **Previously mined**
- **Not previously mined, New Material**
- **Not previously mined**

- **Australia**: 8
- **Bolivia**: 6
- **Canada**: 5
- **Czech Republic**: 4
- **DRC**: 3
- **France**: 2
- **Germany**: 1
- **India**: 0
- **Iran**: 0
- **Italy**: 0
- **Kazakhstan**: 0
- **Malaysia**: 0
- **Mexico**: 0
- **Nambia**: 0
- **Peru**: 0
- **Philippines**: 0
- **Portugal**: 0
- **Russia**: 0
- **South Africa**: 0
- **Spain**: 0
- **Uganda**: 0
- **USA**: 0
- **Zambia**: 0
- **Zimbabwe**: 0

- ~84% of case studies addressing minerals that were previously mined
- ~26% of case studies addressing also minerals that weren’t previously mined
- New material = waste valuable “as is”
Resource assessment

- Only 36% of case studies have a complete characterization (referred to the parameters considered)

Parameter

- Location
- Volumes or masses
- Chemical specification
- Particle sizes and distribution
- Material composition
- Water content
- Leachates
Resource assessment

- Socio-political acceptance and environmental impact are mostly neglected
Evidence review
Results & discussion

Resource assessment

Classification

- No case studies classified using:
  - UNFC (but there are a few from research works, to be included)
  - PERC
  - CRIRSCO-to-UNFC conversion has been tested on a selection of case studies (V. Correia and M. Neumann)
Lessons learned

- Mining / metallurgical residues are still widely unexplored or not classified

- Social & Environmental impacts need to be more and better addressed

- The proposed systematic analysis may be the basis of a more effective decision support tool for RMs supply risk assessment
Future works

Complete the review of about 90 research projects/initiatives dealing with primary/secondary resources exploration, characterization, evaluation, processing, impact assessment

Publish the reviews in a scientific journal (manuscript writing ongoing)

Call for expression of interest

- Increase case studies list involving the wider experts community (e.g. building an online tool)
- Convert CRIRSCO to UNFC numbers for collected case studies
- Apply UNFC to case studies which have not been classified until now

Benefits: increased awareness on UNFC potential, challenges and benefits of UNFC highlighted, improved knowledge on domestic resources, …
Thank you!

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UNECE
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