TOWARDS A SUSTAINABLE MINING INDUSTRY: THE EXPERIENCE OF ECOMETALES

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The challenge to concentrate impurities

- Increasing limits to smelter emissions ($SO_2$, As, Hg).
- Impact on environmental footprint profile of products (e.g.; cathodes).
- Decreasing maximal acceptable levels of impurities in some markets (e.g., China; As,$<0.5\%$).
- Conflicts with local communities to transportation routes or unloading and storage facilities.
- Increasingly restrictive Occupational Exposure Levels (OEL) in processing facilities.
- Impact on hazard classification of concentrates and the associated handling and transportation restrictions (e.g.; MARPOL Annex V restrictions for transportation of bulk products by sea).
Arsenic in the copper mining industry

Sources: Codelco and COCHILCO (2016).
The hidden potential of impurities

Waste of primary mining contain traces that are both impurities and resources

Example of composition of a Cu Concs

Most of these elements end up in wastes. The challenge is decreasing the undesirable impurities and at the same time... Recover some of them as resources.

<table>
<thead>
<tr>
<th>Element</th>
<th>%</th>
<th>Elemento</th>
<th>%</th>
<th>Elemento</th>
<th>%</th>
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<tbody>
<tr>
<td>Berilio</td>
<td>&lt; 0,00005</td>
<td>Zinc</td>
<td>2,65</td>
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<td>Aluminio</td>
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<td>Molibdeno</td>
<td>0,0400</td>
<td>Sodio</td>
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<td>Calcio</td>
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<td>Plata</td>
<td>&gt;0,01</td>
<td>Fósforo</td>
<td>0,0130</td>
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<td>Azufre</td>
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<td>Cadmio</td>
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<td>Escandio</td>
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<td>Antimonio</td>
<td>0,1380</td>
<td>Estroncio</td>
<td>0,0115</td>
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<tr>
<td>Cromo</td>
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<td>Bario</td>
<td>0,0100</td>
<td>Torio</td>
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<td>Manganeso</td>
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<td>Cesio</td>
<td>0,000086</td>
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<td>Mercurio</td>
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<td>Uranio</td>
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<td>Vanadio</td>
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<td>Wolframio</td>
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<td>Galio</td>
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</tbody>
</table>
**EcoMetales Limited**

### About us

A flue dust leaching plant followed by a selective arsenic precipitation plant from existing facilities (BioCOP).

- **ECL**, 100% subsidiary of CODELCO, focused on deliver environmental solutions and value recovery for mining residues.
- **ECL** has a total workforce of about 300 people and is supported by 250 environmental permits.
- **ECL** has processed more than 400,000 tons of residues recovering 80,000 tons of copper. Since the start-up of the As stabilization plant, more than 7,500 tons of arsenic have been stabilized.

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### Key issues for the project development

- Long-term vision, discipline and willingness to take risks.
- The need for low-cost solutions.
- Lack of availability of solutions on the market.
- Focused research. Pilot trials to elucidate unknown process variables and scale-up.
- **Brownfield project**
  
  The need of optimizing existing facilities.

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Human resources
Our people

ECL WORKFORCE

153
MEN
122
WOMEN
31

20% MEN
80% WOMEN
Arsenic stabilization

Alternatives

Scorodite in atmospheric conditions:
- EcoMetales and Dowa process.

Scorodite in Autoclave:
- (POX Process).

Other alternatives in the Industry:
- Calcium arsenite
- Arsenical ferriydrite.
- Arsenic Trisulphide.

Alternatives at pilot scale:
- Bio scorodite
- As in glass
EcoMetales Plant:
Flue dust leaching process

- Refinery and acid plant effluents
- Dilution water
- Flue dust
- Sulphuric acid

Leaching 1 → Leaching 2 → THICKENER

Pregnant Leach Solution (PLS) to arsenic stabilization stage

Leaching residue to ECL as a byproduct

42,308 ton treated residues
71,139 m³

Reference, EcoMetales 2016.
EcoMetales Plant:
Arsenic stabilization process

Limestone slurry
Steam
Magnetite
PLS
H$_2$O$_2$ 70%

Storage tank
Oxidation stage
Precipitation 1
Precipitation 2
THICKENER
FILTER

PLS to SX-EW

7.947 tpy Fine copper

Scorodite to EcoMetales landfill

28.098 ton.
Scorodite

3.545 tpy of arsenic stabilized

Plant mass balance 2016
TCLP/SPLC Stability tests

Key for good TCLP/SPLP results at industrial scale

Ensure a crystalline shape of scorodite. We check this parameter every 10 days using XRD analysis.

A very important issue is the cake washing in the dewatering stage.

The particle size should hopefully be over 5 microns controlled by the seeding, mixing and HRT.

Unexpected change in the feed with high amount of arsenic (III)
EcoMetales stable residue landfill

Surface area: hectares
25

Estimated lifespan: years
15

Ton storage capacity
1,370,000
The Greatest Challenge
The construction of an industrial plant based on a scientific paper

Continuous learning during the plant operation

2006
Precipitation of scorodite at laboratory scale.

2010-2012
- PAA Project
- Pilot Plant Trials
- PAA Construction
- PAA Start-up

2013
Start of operation of PAA.

2014
- Improvement of boiler use and limestone preparation stage
- Optimization of ferric solution preparation stage

2015
- Improvement of oxidation stage

2016
- Improvement of precipitation stage

2017
- Optimization of automatic control

2018
- Continuous learning during the plant operation
EcoMetales

Growth opportunities and development projects
The process considers the leaching of complex copper concentrates through a high-pressure vessel. The arsenic stabilization is also performed inside the vessel.

The project capacity is 200,000 t/y, the go-ahead decision should be taken during 2017.

**Advantages:**

- Almost zero emission
- Stable residue as scorodite
- Utilization of existing SX-EW facilities
- Low water consumption
- Competitive costs

The schedule defines the start-up for the new facilities in 2020.

**Capex USD $ 324.000.000**
Stable waste and metal recovery: Exciting market for sustainable mining industry

- Conviction - focus - perseverance
- Identify needs and challenges
- Teamwork - Networking - collaboration
- Partnerships with companies, technology centers and universities
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VALUE

- Decreasing the costs of the stabilization process.
- Minimizing the volume of waste.
- Full stability of residues.
- Recovering value from byproducts and “impurities”.
- Recycling the waste.
- Strategic alliances (universities, research centers, tech companies).
- Participation of public and private investment funds to develop environmental solutions.
- Sustainable processes for stabilizing the waste.
- Value recovery from waste.
- Circular economy as a driving force (tailing treatment, among others).
For treating or recovering complex materials, the dilution is not a solution. It may solve short-term issues but it kicks the problem forward.

Safe disposal or, better yet, recovery of impurities as values leads to long-term sustainability.

What is our legacy for future generations?

A challenge from both ethical and business viewpoints.
Contact us for further information

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