
Boliden's Perspective on Tailings Reprocessing and By-Product Extraction from Waste Streams

Anders Sand

Research Manager

Boliden Mines

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Boliden – The Company

- European mining and smelter company
- Founded 1924, based on rich gold discovery in Northern Sweden
- 6000+ employees
- Turnover of 5.6 billion € (2020)
- Profit 0.8 billion € (2020)
- Main commodities Cu, Zn, Pb, Ag, Au, Ni, Te, PGE, etc.
- 6 mines or mine areas, 5 smelters
- About 50 historical mine sites, most in the Boliden area in Sweden
- Significant actor in recycling (WEEE, batteries, etc.)



Figures based on the 2020 Annual Report

Boliden Approach – Recycling Mining Waste

Already an established business concept, but...

- Often preceded by decades of studies and research
- Usually extraction of minor constituents (e.g. residual valuable metals)
- Practical applications for bulk of processing rejects - still a huge challenge!
 - Some 60Mtons of tailings produced annually, 3Mtons used in backfill.
 - Largest mines tend to be located far away from populated areas. Logistics/costs → prohibitive for low value applications.
- Rarely very profitable
 - Small profit or break-even. Principle: income should pay for the (known) material handling and reprocessing costs
 - Economy difficult to quantify, particularly alternative costs



Tailings reprocessing – opportunities and limitations



Proper estimation of business potential of processing rejects should include alternative costs/value of:

- Reclamation costs
- Effects on land use (+ or -)
- Environmental and safety risks
- Monitoring (and mitigation actions)
- Long term water handling, if relevant
- Goodwill and social acceptance?
- Etc.

In Sweden company responsibility for closed-down mining operations lasts forever, should be managed based on best available technology.

Boliden also commits to maintaining compensation areas (internal standard).

Example: Working with by-products at the Aitik mine



Mining started '68 Cu(Au)-concentrate

Mica production, replacing asbestos as filler in plastic, discontinued less than 10 years later

1960

1970

1980

1990

2000

2010

2020

Evaluation of pyrite byproduct

Studies on Ti, V, P, Mo, Co and Ni recovery '71
Studies on mica byproducts (muscovite, biotite) '74
Studies on recovering REE from bulk tailings '74
Studies on industrial minerals as possible by-product '76

Co potential in HS tailings 500t/y
by desktop study (5% of EU need)

Studies on Scheelite recovery (CaWO_4)
Studies on producing Mo from Cu-concentrate.
Studies on Au recovery from HS tailings.

Study on Mo byproduct

Study on magnetite byproduct
Ti extraction from tailings

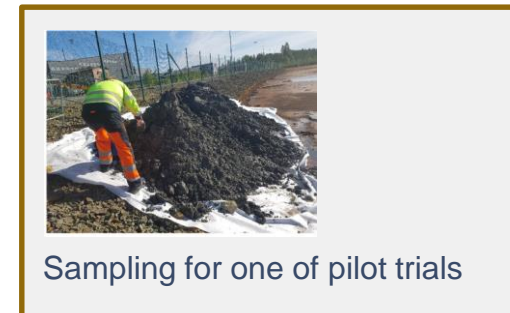


Example: Reprocessing plan in the Boliden area

- 3-3.5Mtons of tailings/residues identified for reprocessing in Boliden Area
 - Preceded by studies 1980-2011
 - Up to 9%Zn, 2g/t Au, 60g/ton Ag
 - 2011: Positive project NPV. Approx 10M€ estimated net income
- First phase: the “Korea Dam project”
 - Successful reprocessing, based on combination of gravimetry, flotation and leaching
 - 60%Zn, 73%Au, 72%Ag recoveries
- Sustainability benefits
 - Environmental liability removed, land reclamation started
 - Societal engagement in deciding on reclaimed land use
 - No noticeable social acceptance benefits



Before and after: Reprocessing “Korea” tailings 2018-2020



Sampling for one of pilot trials

Risks and challenges – a company perspective!

- Extremely long processes and escalating costs for permitting
 - 4-8 years minimum, at least 10 years in “greenfield” projects. Arbitrary processes.
 - Long time to generate cash flow, development phase ever more costly and insecure – reduced NPV.

- General lack of predictivity, economical challenges
 - Difficult to grasp the actual economic benefits and liabilities of different options.
 - Typically only economical if most of plant & infrastructure & permits already in place.
 - How to predict supply-demand situation and metal prices 10 years into the future, particularly for more “exotic” elements?

- Policy issues and classification of wastes?
 - Reprocessing for economic and environmental benefits might be prevented by taxation, depending how new residues are classified.
 - Use of extractive wastes in construction materials?
 - Suboptimal system setup also from environmental standpoint.

What is needed?

- Predictivity: Cost/benefits of reprocessing versus alternative cost of long term tailings management need to be known.
- Holistic view: We need to understand that we are dealing with trade-offs: Climate vs environment? Properties of new residues? Policy and legal constraints?
- Leadership: Ultimately, how does Europe want to handle its resource challenge? How to simultaneously address supply, environmental, economic, social and climate challenges?
- Cooperation: We need to start working together!



Te
Pb
Cu
Ag
Co
Ni
Zn



There are no wastes, only potential future resources!

Anders Sand (D.Sc., Docent)

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SE-936 81 Boliden, Sweden

Visiting address: Finnforsvägen 4

anders.sand@boliden.com



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