Strategic innovation programme for the Swedish mining and metal producing industry

Pär Weihed
Project manager
Strategic innovation agenda

Strategic innovation programme (SIP)
Key

Beyond Vision 2030
No critical metals
Zero waste
Fully automated mining operations without human interface

Vision 2030
No harmful emissions
Waste into products
Fully integrated resource characterization
3D exploration models ready for major belts
Minimized climate impact
Improved resource efficiency

Performance

Indicators

>30% CO₂ reduction
>3 new products from existing process streams
>30% increase in no: of operating mines
>30% less deposited waste
>30% energy reduction
>30% increased resources base
>30% decrease of residues
New approaches:

• Mining towards continuous processes
• Better methods to *characterize* the host rock and the ore to *maximize* the inherent values as well as to *minimize* non-marketable residues
• Better command of “soft factors”, stimulate improved safety culture and change image of the sector
• Nurture a cross-sectorial transfer of knowledge and experience to master the challenges ahead
Anticipated effects 2013–2016:

• Sweden has become a well-known and appreciated EU research and innovation partner
• The Swedish mining cluster has been strengthened and the technology providers offer new or improved products and services
• The environmental footprint has been reduced by lower emissions and improved resource and energy efficiency
• The mining and metal producing sector has become more attractive for young talented men and women
• The global competitiveness and sustainability has been further strengthened
Research and Innovation projects, activities, c. 200 MSEK 2013–2016

TRL-level 4-7
Organisations supporting the SIP STRIM
(signed LoI)

Industry
ABB
Atlas Copco
Boliden
LKAB
Lunding Mining (Zinkgruvan AB)
Raw Materials Group
Sandvik
SKB
Stena Recycling

Academia
Luleå University of Technology
Umeå University
Uppsala University

Public organisations
Geological Survey of Sweden

Research institutes
Swerea MEFOS
SP

NGOs
Bergkraft
Georange

Financial “commitment” approx. 100 MSEK 2014–2016
<table>
<thead>
<tr>
<th>Project</th>
<th>Funding (MSEK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Konceptuell modellering och prospekteringskriterier för stratiforma Zn-Pb-Ag-(Cu) fyndigheter i Bergslagen</td>
<td>5,6</td>
</tr>
<tr>
<td>Förbättrad resurseffektivitet genom dynamiskt styrd uistlåning</td>
<td>11,9</td>
</tr>
<tr>
<td>BIOMET: Effektiv metalutvinning av gruvvatten genom biologisk behandling</td>
<td>0,9</td>
</tr>
<tr>
<td>Using by-products for prevention of sulphide oxidation in reactive mine waste</td>
<td>0,5</td>
</tr>
<tr>
<td>Multi-scale 4-D geological modelling of the Gällivare area</td>
<td>9,4</td>
</tr>
<tr>
<td>From face to surface - optimised processes &amp; increased understanding of fragmentation</td>
<td>13,6</td>
</tr>
<tr>
<td>HIFLOAT - Optimala cellutformning ingen för enskilda flotationsceller</td>
<td>5,9</td>
</tr>
<tr>
<td>Use of carbon and metal containing residue materials as reductant in base metals production</td>
<td>6,8</td>
</tr>
<tr>
<td>Reduction of nitrogen discharges in mining processes and mitigating its environmental impact - mining</td>
<td>9,7</td>
</tr>
<tr>
<td>Deep innovative exploration</td>
<td></td>
</tr>
<tr>
<td>Mining</td>
<td></td>
</tr>
<tr>
<td>Mineral processing</td>
<td></td>
</tr>
<tr>
<td>Metallurgy &amp; recycling</td>
<td></td>
</tr>
<tr>
<td>Reclamation &amp; environmental performance</td>
<td></td>
</tr>
<tr>
<td>Attraktiv gruva för alla</td>
<td>1,0</td>
</tr>
<tr>
<td>Attractive workplaces</td>
<td></td>
</tr>
<tr>
<td>PREP</td>
<td>15,6</td>
</tr>
<tr>
<td>Innovativ djupprospektering</td>
<td>1,2</td>
</tr>
<tr>
<td>Utveckling av en ny metod för utvärdering av bergförstärkning ens funktion i seismiskt aktiva gruvor</td>
<td>13,3</td>
</tr>
<tr>
<td>Användande av restprodukter för förhindrande av sulfidoxidation i gruvavfall</td>
<td>13,5</td>
</tr>
<tr>
<td>Attraktiv råvaruförsörjning</td>
<td>1,2</td>
</tr>
</tbody>
</table>
Innovative Deep Exploration

INDEX

Klas Hjort
Uppsala University
Partners

- **Uppsala University**: geophysics, geochemistry, microsystems technology
- **Atlas Copco**: gatekeeping, drilling technology implications
- **Boliden**: end user, field tests geophysics borehole probes/shuttles and Orexplore’s geochemical system
- **LKAB**: end user, field tests geophysics borehole probes/shuttles
- **Orexplore**: technology developer X-ray geochemical system: deep XRF and tomography
Objectives and goal

- Deep exploration beyond one kilometre can benefit greatly by getting faster feedback on the physical and chemical state of the rock.
- The goal is to improve the work flow and creativity for geologists by new technology for geophysical sensors and geochemical analyses at the bore hole.
- New miniaturized technology for sensors and chemical analysis will be developed and tested in the field. The study will have a particular focus on the problems and needs arising from the exploration at depths greater than one kilometer.
- This project is the first phase of three, which shall help distinguish Swedish industry from existing research and development in the world.
Pre-study inspired by DET-CRC

- Uppsala University
- Luleå Technical University
- Acreo
- KIMAB
- LKAB
- Boliden
- Atlas Copco
- Wassara
- Orexplore
- (SGU)

- Drilling technology
- Geology
- Geo physics
- Geo chemistry
- Sensor
- Materials science
- Miniaturized systems
Inspiration from DET CRC

- Three focus areas
  - Drilling
  - Logging
  - Chemistry
Lab-at-Rig of REFLEX
Hyperspectral core logging

• SEG 2015: High-Resolution VNIR-SWIR Core Logging: A Revolutionary New Tool for Exploration, Mining, and Research
  – Newcrest Mining Limited, Melbourne 3004, Australia
  – Corescan Pty Ltd, Belmont 6104, Australia

• A new multisensor automated high-speed hyperspectral core logging platform provides a step change in characterization of ore systems.

• With a spatial resolution down to 0.5 mm, complete drill core-based, deposit-scale petrographic studies of relevance to exploration, mining, and research.

• Needs huge data handling and spectral classification and mineral identification algorithms process each spectral pixel and compare the response to an established mineral library: on-site handling!
LKAB and Boliden want collaboration between Atlas Copco and Wassara

- Fast hammer until we reach interesting depths and from there diamond core drilling
- Support for drilling: digitalized rigg; sensors and chemical analyses at the drilling rigg; direct visualization
- Analyse of drill mud (cf. DET CRC) and core for support
Mini-sub

- From studies of sub-glacial lakes
- Large like two cans in row
- Specially developed miniaturized instruments: microsonar, diffractive laser optics for 3D camera, salinity sensor, flow sensor, particle collector
- Fibre optics for data and energy transfer
World class miniaturization
Down hole magnetometers

- Frequency range for AMT and CSAMT: 1 Hz - 10 kHz
- Define requirements from surface sensors
- Wants 3D-SQUID
Seismic measurements at drilling
Data handling and modeling
• Orexplore is developing an X-ray instrument that can be used at the drilling site (600 kg cabinet transported in small container).
• This AXM instrument (Attenuation and XRF combined Measurement) do deep XRF and heavy element X-ray absorption tomography with dual heads. One meter lengths of core will take less than 20 min.
• In normal procedure, this is a push-and-play instrument.
• Today for elements between atom number 25 and 82 (Mn – Pb)
• The aim is to reach down to atom number 13 (Al)
To bring with you

- There are much more ore in the depth
- We need to reduce exploration costs
- Innovative deep exploration may improve creativity

- New miniaturized sensors in the bore hole and chemical analyses at its side
- Want to increase international collaboration