SIP | STRIM PROJECTS 2019

What is SIP|STRIM?

The Strategic Innovation Programme for the Swedish Mining and Metal Producing Industry, SIP STRIM, has been running since 2013. The programme is funded by its stakeholders and partners, and by Vinnova, the Swedish Energy Agency and Formas.

The programme has its basis in the Strategic Research and Innovation Roadmap for the Swedish Mining, Mineral and Metal producing industry, and all projects within the programme aim to realise the goals and vision stated in the roadmap.

Apart from innovation projects, the programme organises idea competitions aiming at identifying new project ideas, workshops, education activities and other activities aiming at outreach and internationalisation.

Our innovation projects range from short pre-studies, to fullscale innovation projects, pilot tests and demonstration projects. All projects are initiated by our various stakeholders and each fullscale and pilot project involves at least two partners from the industry and one academic partner.

In addition to these projects, a number of strategic projects are initiated by the programme management each year. In this folder, all our current projects are presented. For more information about the projects, please contact the project leaders or SIP STRIM.

CONTACT

www.sipstrim.se
www.twitter.com/sipstrim
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Contents

Photo: Boliden.

FULL-SCALE PROJECT

Innovative quality assured fayalite slag products (IQSLAG)

Project leader: Caisa Samuelsson, Luleå University of Technology, caisa.samuelsson@ltu.se
Project duration: 2016–2019
Partners: Nordkalk, Boliden Mineral AB, PEAB, XORE AB

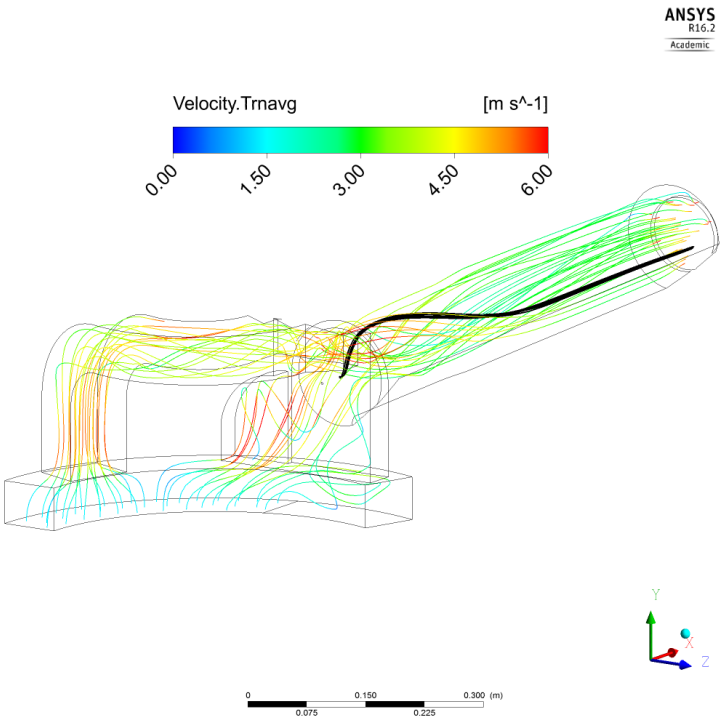
The aim of this project is to develop new circular use of the fayalite slag from base metal smelters and to assure the environmental quality of present and new slag products. This will need extensive development work and collaboration between mining, mineral and metallurgical industry, construction companies and development of measurement techniques. A fundamental understanding of mechanisms occurring in the processing of liquid slag will enhance the possibility to modify the slag with the purpose to produce tailor-made products based on the slag. Understanding of the long term leaching mechanisms of solidified slag products and the influence of ambient conditions, ageing, will give valuable information for a sustainable use of material.

FULL-SCALE PROJECT

Development of closing and reopening criteria for seismically active mines

Project leader: Savka Dineva, Luleå University of Technology, savka.dineva@ltu.se
Project duration: 2016–2019
Partners: LKAB, Boliden AB

A typical problem related to deep mining is mining-induced seismicity which in principal means that events similar to earthquakes occur as a result of the mining and the resulting stress re-distribution. This project aims to combine all available state-of-the-art knowledge and experience worldwide with high-quality unique data for seismic event parameters, local stress changes, and damage due to seismic event (rockbursts) and develop criteria specific for underground mines in Sweden that can be used for closing or re-opening of specific areas in case of increased seismic risk.



FULL-SCALE PROJECT

New digital 3D model of the Grate Kiln pellets process for reduced energy consumption and emissions

Project leader: Staffan Lundström, Luleå University of Technology, staffan.lundstrom@ltu.se
Project duration: 2017–2020
Partners: LKAB, Taoshi Energiteknik AB

The main aim is to develop a new digital 3D model that can be used to control and optimise the flow field in rotary kilns for reduced energy consumption and environmental impact and increased pellet quality. Additional goals are: a general simulation methodology that can be used on any complex system involving fluid flow; increased understanding of the pelletising process regarding at least three flow phenomena; and a demonstration of how advanced experimental techniques can be used in harsh industrial environments. Implementation of the model can help reduce the environmental foot-print of mining and contribute to sustainability in terms of more optimal use of energy and reduced emissions, as well as increasing the quality of the pellets. The results will also form a basis for innovative solutions regarding in-situ flow control.

Photo: Boliden. Jeanette Hägglund

FULL-SCALE PROJECT

Walk the talk – sustainability management system for social acceptance

Project leader: Helena Ranängen, Luleå University of Technology, helena.ranangen@ltu.se
Project duration: 2017–2020
Partners: Boliden AB, Svemin

The purpose of this project is to improve the Swedish mining industry's sustainability efforts by developing and implementing a sustainability management system (SMS) for social acceptance which, based on stakeholder dialogue creates, implements, evaluates and develops sustainable processes along the entire value chain. The project aims to test whether previous research, which is more conceptual by its nature, can be applied in practice. SMS will be integrated into the company's existing operational management systems and will thus make an important contribution to the empirical research on how CSR is practiced from an inside perspective. The project will be implemented through: 1. Literature reviews. 2. Interactive workshops. 3. Stakeholder surveys. 4. Stakeholder interviews. 5. Development and documentation of SMS. 6. Dissemination of results via national and international conferences and scientific publications.

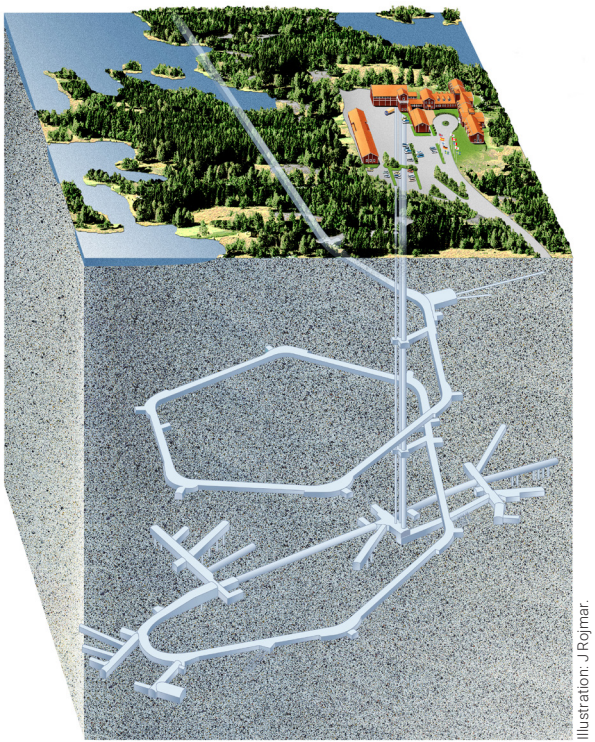


Illustration: J Rojmar.

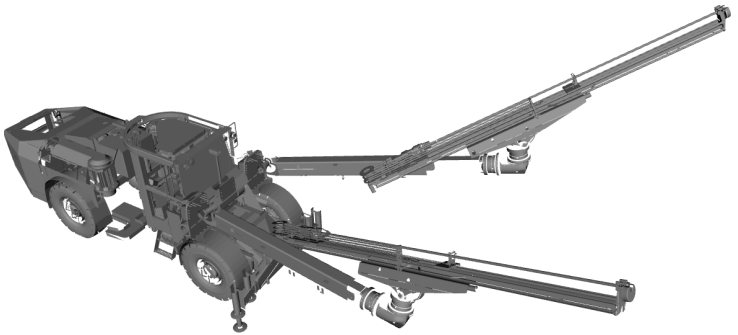
FULL-SCALE PROJECT

Field test of FBG-based sensor system – beneficial for industry and society

Project leader: Linda Sharp, Maskinteknik i Oskarshamn AB, linda@maskinteknikab.se
Project duration: 2017–2019
Partners: Svensk Kärnbränslehantering AB (SKB), RISE Acreo AB, SKB Näringslivsutveckling AB, Oskarshamns kommun

The project intends to further the development process, to get closer to product and commercialisation of an FBG-based sensor system for measuring bedrock movements. The project has three main objectives: 1) to further develop and manufacture an FBG-based sensor system, 2) to field test the sensor system in the Äspö Hard Rock Laboratory for one year to verify its stability and reliability, and 3) to develop a plan for commercialisation.

The project is managed by the company in close collaboration with the project group and a reference group consisting of numerous stakeholders and experts from the mining, infrastructure, and nuclear waste storage industries. When the project is completed, the sensor system should have reached TRL 5–6.



FULL-SCALE PROJECT

Tracking and control of articulated machines through remote sensing

Project leader: Todor Stoyanov, Örebro University, todor.stoyanov@oru.se
Project duration: 2017–2020
Partners: Alfred Nobel Science Park, Atlas Copco Rock Drills, Zinkgruvan AB

A key enabling technology for remote machine operation is the ability to estimate and control the full machine state. In the this project we will devise and implement novel methods for estimating the state of articulated manipulators using remote depth sensor measurements. We will verify the validity and utility of the state estimate by using it in a feedback controller. By removing all sensor hardware from the manipulator, we will greatly increase hardware robustness to damage and reduce repair and maintenance costs.

The project hopes to result in novel technology within the following objectives: reliable remote sensing in harsh mining environments; accurate manipulator tracking; and robust feedback control. The project will develop software modules for estimating the state of an articulated machine, using remote sensing.

Photo: Lars deWall.

FULL-SCALE PROJECT

Face-to-Mill

Project leader: Daniel Johansson, Luleå University of Technology, daniel.johansson@ltu.se
Project duration: 2017–2019
Partners: Atlas Copco, Boliden AB, Forcit Sweden AB

The main objective of the project is to increase the overall production capacity in large open-pit mining. This is done by adapting the findings from the previous project Face-to-Surface I, and extending the project scope of the production optimisation to also include mill performance. To improve the knowledge of how varying rock mass characteristics can be controlled with adaptive blasting technique and procedures, to optimal fragmentation through the mining chain. The suggested methodology involves extensive machine and operation monitoring, where a big-data approach is suggested. The project aims to suggest an overall optimal fragmentation through the mining chain, to develop a technique for adaptive charging of explosives based on rock characteristics and to reduce the total energy consumption of the mining operation.

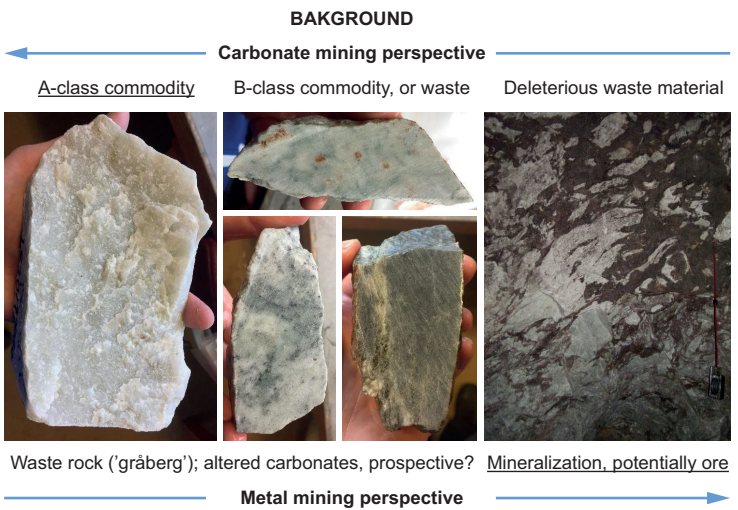
Photo: Khushie singh (CC BY-SA 4.0)

FULL-SCALE PROJECT

Face-to-Surface II – Improved production efficiency in sublevel caving

Project leader: Håkan Schunnesson, Luleå University of Technology, hakan.schunnesson@ltu.se
Project duration: 2017–2019
Partners: Agio system och kompetens i Skandinavien AB, Atlas Copco, LKAB

The objective of the project is to increase production capacity and reduce production cost for sublevel caving mines by optimising fragmentation, using optimised blast hole sizes, improved chargeability, a new technique for boulder handling and improved overall production planning. The research methodology combines state-of-the-art investigation, machine monitoring, borehole filming and video recording, using data mining and big-data analysis, interviews and field tests. The project will develop production tools for material characterisation for charging support. The project will also provide a deeper understanding of how hole sizes influence ground vibrations. The project will develop procedures for how production planning can be improved by better rock mass characterisation and generate a better and deeper understanding of how mobile boulder breakers can reduce production disturbances.



FULL-SCALE PROJECT

VectOre – Exploration criteria for polymetallic sulphide mineralisation and industrial carbonates

Project leader: Nils Jansson, Luleå University of Technology, nils.jansson@ltu.se
Project duration: 2017–2020
Partners: Björka Mineral AB, Boliden AB

The project aims at improving exploration criteria for polymetallic sulphide deposits (Zn-Pb-Ag) and carbonate deposits (calcite and dolomite). Both are spatially associated with marble units in Bergslagen and some of the best quality industrial carbonate deposits occur in alteration haloes related to nearby sulphide deposits. The main aim of the project is to understand the chemical, mineralogical and isotopic zonation of such alteration haloes. The c. 40 km long marble occurrence in the Sala area will be investigated with emphasis on stratigraphy, structure, lithogeochemistry, stable isotopes and mineralogy. The distribution of mineral deposits will be related back to variations in the marble unit on a regional scale. Detailed studies will be conducted around known sulphide and carbonate occurrences in the Sala-Tistbrottet area. Our geochemical and mineralogical data will also be used to investiage the relationship between marble composition and key parameters of interest to the carbonate industry, such as lightness.

FULL-SCALE PROJECT

Mining industry and indigenous people: regulations, best practice and social innovation

Project leader: Karin Beland Lindahl, Luleå University of Technology, karin.beland.lindahl@ltu.se
Project duration: 2017–2020
Partners: CAMECO, Das Nedhe Development, English River First Nation, University of Northern British Columbia, University of Saskatchewan

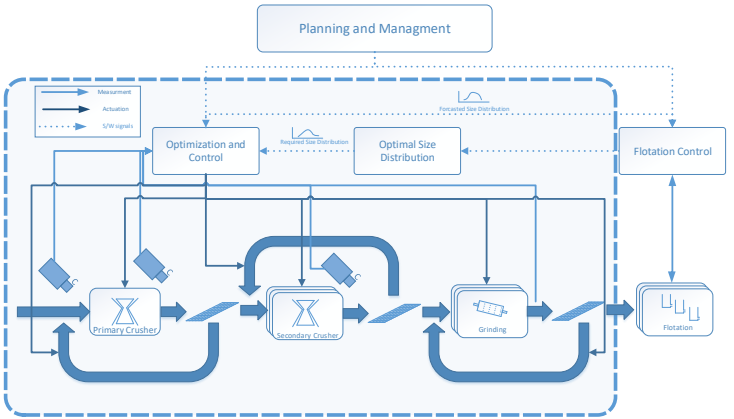
Sweden has experienced an increased level of conflict over mine establishment, particularly in relation to indigenous land use. This project aims to develop tools to manage Swedish land use conflicts involving industry, indigenous communities and the state by drawing on Canadian comparisons and experience. More specifically, it will compare social licensing (SLO) and mine establishment across Swedish and Canadian jurisdictions to explore the role of the regulatory frameworks and identify well-functioning practices in relation to indigenous rights and land use. Better knowledge about the role of institutions for SLO will enable Swedish policy makers to create conditions that support mutually beneficial interactions between company and community.

FULL-SCALE PROJECT

Estimation of the risk of rockfall and optimisation of rock reinforcement in deep underground mines

Project leader: Erling Nordlund, Luleå University of Technology,
erling.nordlund@ltu.se
Project duration: 2017–2020
Partners: Lundin Mining, Boliden AB, LKAB

The aim of the project is to improve safety and productivity, and reduce the ore losses, dilution and the amount of waste rock by improving the ground control strategy. Objectives in detail are to: improve the understanding of the failure mechanism of rockfalls, develop statistical analysis methods for assessing rockfall hazards, develop design guidelines for support of large potentially unstable volumes, and develop design guidelines for bolt-shotcrete arches and mesh and mesh overlaps. The successful completion of this project will result in: 1. An innovative methodology for assessing the rockfall hazards based on deterministic (forensic investigation) and statistical (DFN modelling) analyses. 2. Improved performance of the rock support system to prevent large rockfalls controlled by geological structures through new design guidelines. 3. Improved performance of bolt-shotcrete arches and welded mesh support by new design guidelines. 4. Educated qualified rock engineering personnel for the mining industry.



FULL-SCALE PROJECT

Efficient comminution operation (ECO)

Project leader: Andreas Johansson, Luleå University of Technology, andreas.johansson@ltu.se
Project duration: 2017–2020
Partners: Innovative Machine Vision Pty Ltd, Optimation AB, Vale S.A.

Comminution (crushing and grinding) accounts for about 4% of the world's energy consumption, and the environmental impact from the production of tailings due to overgrinding can be significant. In this project, we will consider the problem of improving efficiency in comminution chains in the presence of changes in ore properties, product demands, etc. This will be accomplished by collecting online measurements of variables such as ore size distributions and to change machine speeds and other variables continuously to achieve optimised operation. Advanced measurement equipment for measurement of size distribution of ore streams will be installed in a Brazilian mine facility. Aided by data from these, dynamic models for crushing and grinding processes will be developed. The models will be used for developing algorithms for optimised control of the comminution processes. The potential of these algorithms for process optimisation will be tested in simulation but also implemented in normal operation where possible.

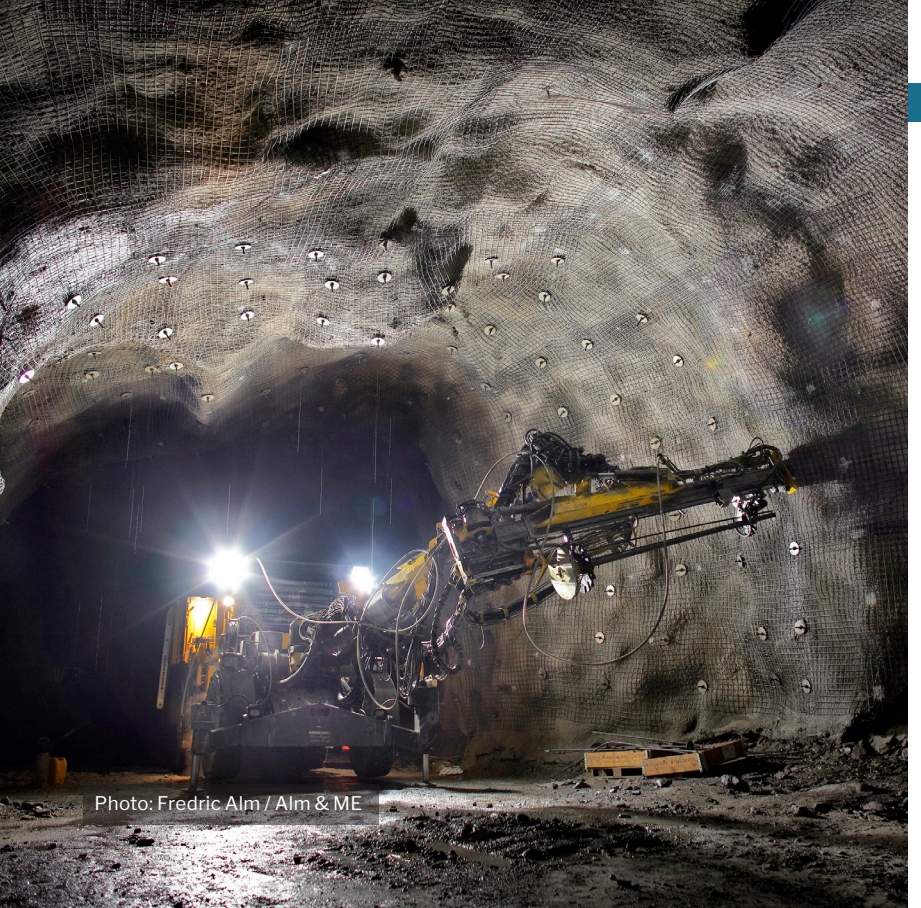


Photo: Fredric Alm / Alm & ME

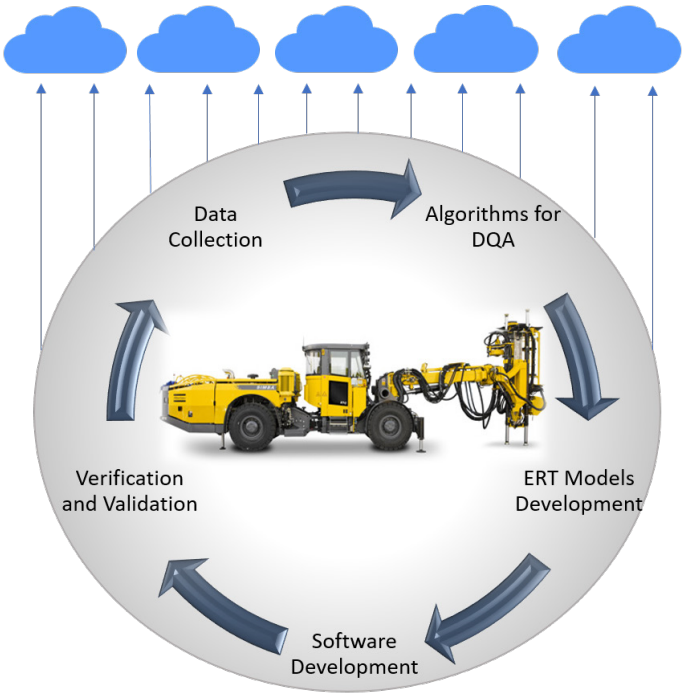
FULL-SCALE PROJECT

Strategies and indicators for mine safety

Project leader: Jan Johansson, Luleå University of Technology, jan.johansson@ltu.se
Project duration: June 2018-May 2021
Partners: Drillcon AB, Zinkgruvan Mining AB, Boliden Mineral AB, Cementa AB, LKAB, Bergteamet AB, Svemin

The purpose of the project is to improve workplace safety in the mining industry based on practices, strategies and principles gathered from Swedish and international mining companies. The goal of the project is to develop strategies and proactive indicators aimed at improving safety management and, contribute to making companies in the industry more attractive employers.

The project will develop methods aimed at managing and controlling the work environment by, e.g., highlighting the safety effects of automation and providing an overview of safety in relation to contractors, focusing on safety management and injury prevention. More specifically, the project will provide a quantitative description of the safety situation in a number of Swedish and international mining companies, a description of the safety-related practices in a select number of companies, and an in-depth analysis of these practices and how they can be systematized in terms of proactive safety strategies and indicators.



FULL-SCALE PROJECT

Improving data quality for LCC predictions with cloud services

Project leader: Uday Kumar, Luleå University of Technology, uday.kumar@ltu.se
Project duration: April 2018-March 2021
Partners: Boliden Mineral AB, Epiroc Rock Drills AB

The aim of this project is to develop a framework for data quality analytics (DQA) of MAXIMO database, develop, validate and demonstrate an economic replacement time (ERT) model in the mining environment and to build a generic software that can be used to estimate the ERT of mining production machineries considering real operational parameters in mining environment.

The objectives are to measure and diagnose DQ problems, and develop application tools for improving the quality of MAXIMO data. Further objectives are to minimize the total ownership cost of production machineries and to develop, validate and demonstrate a decision-making tool for the ERT estimation of production machineries. The expected results include a practical optimization model based on the total discounted cost, results visualization and decision support, and a private cloud computing service developed and integrated into the project.

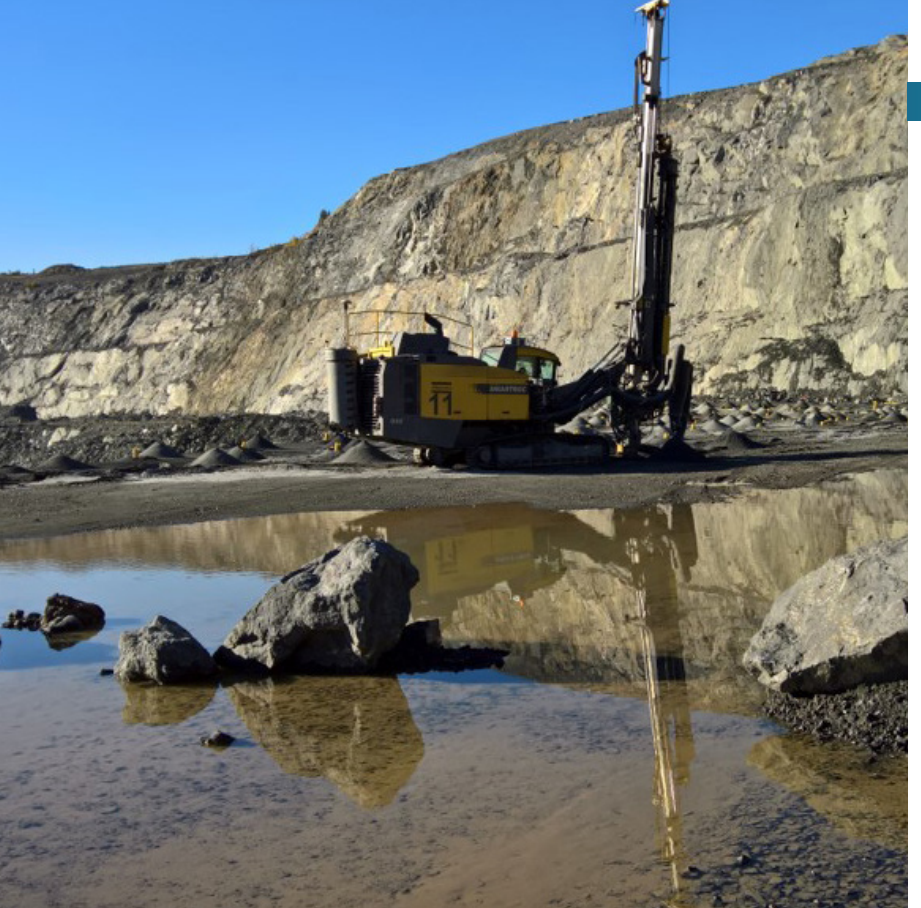
PRE-STUDIES

Stochastic mine design

Project leader: Mathieu Gosselin, Gosselin Mining,
mathieu.gosselin@mail.mcgill.ca
Project duration: March 2018-March 2019
Partners: SOFRECO, McEwen Mining Inc.

Geological uncertainty has a significant impact on the value of mining projects. A new approach is proposed for designing open pit mines based on geological uncertainty that combines stochastically simulated geological models and traditional optimization with routinely used implementations. The aim is to develop designs that capture maximum upside potential whilst minimizing downside risk.

This study will develop, verify and validate development and commercial potential for the new method for future full-scale projects by integrating uncertainty into pit optimization of life-of-mine production planning. In open pit mining applications, tests have shown that stochastic approaches produce a 10 to 25% of additional value for mining operations than the traditional scheduling methods. A stochastic integer formulation solution of the mine production schedule problem generates higher value; this reflects the importance of incorporating geological uncertainty into the scheduler problem formulation.

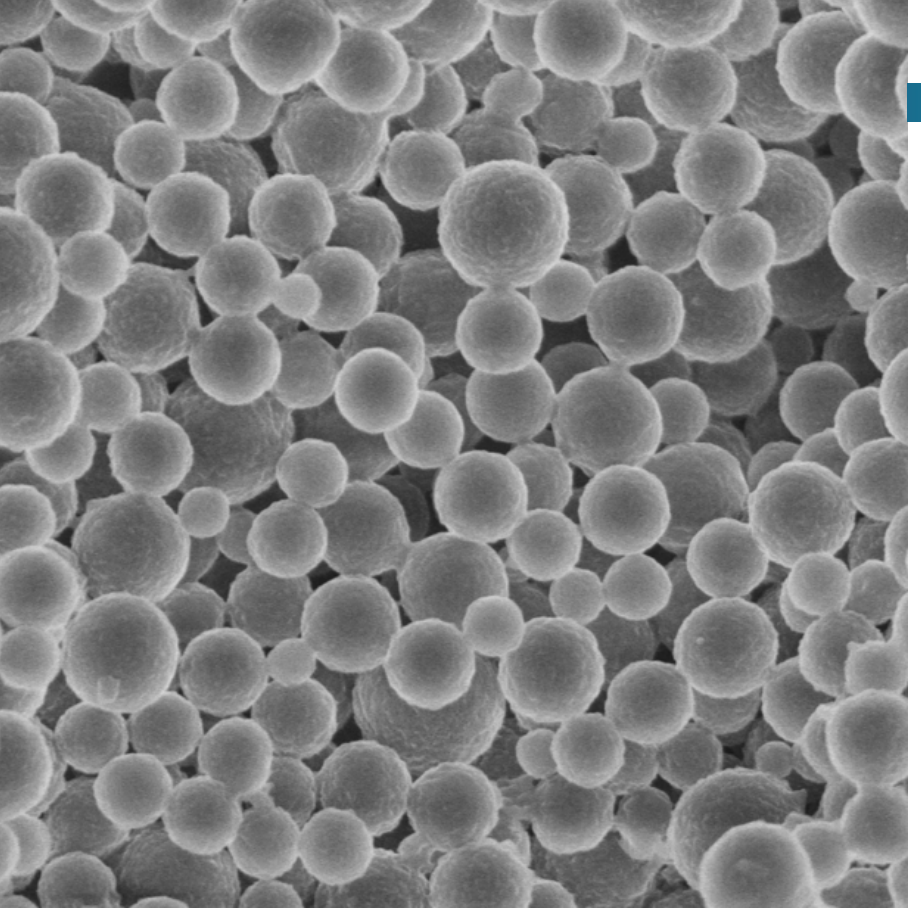


Innovative DTH drill monitoring

Project leader: Håkan Schunnesson, Luleå University of Technology,
hakan.schunnesson@ltu se
Project duration: April-September 2018
Partners: Epiroc Rock Drills AB, LKAB

The purpose is to evaluate the potential with the newly developed MWD technique for pneumatic Down-The-Hole (DTH) drilling. The potential for ore- and ore quality delineation, for determining variation in rock mass quality that affects slope stability and how MWD technique can provide rock mass information to improve blast planning and performance will be evaluated.

The correlation between iron ore grade and the MWD response will be studied to determine how well ore delineation can be made based on MWD technique and how well quality differences within the ore can be described. The MWD response to structural features will be evaluated to foresee stability issues. The last row of holes defining the final wall, is in particular important to prevent blast damage to weak rock sections. The MWD response will be evaluated as input to the blast design. A more detailed description of the rock mass together with the electronic detonators, may provide better fragmentation and improve the productivity.



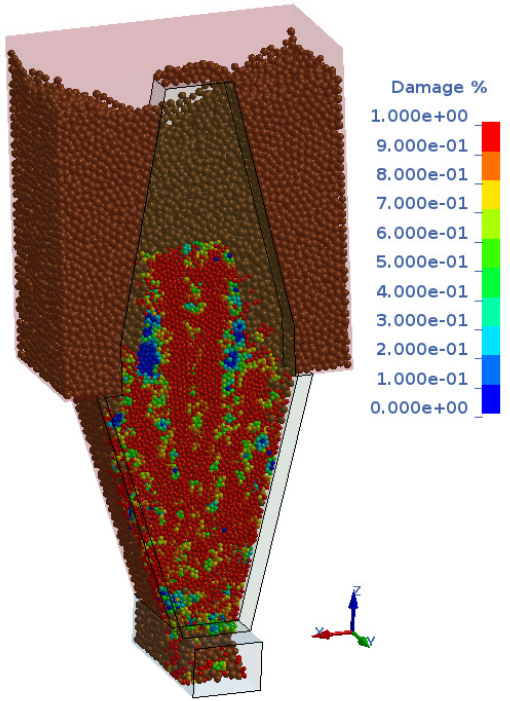
PRE-STUDIES

Lignin-based hydrophobic nanoparticles for sustainable flotation processes (LIGNOFLOT)

Project leader: Pavlos Christakopoulos, Luleå University of Technology, pavlos.christakopoulos@ltu.se
Project duration: March-August 2018
Partners: Boliden Mines, Sveaskog Förvaltnings AB

Selective separation of desired mineral by flotation is one of the most important steps in mining industry. Till now xanthate based surface active agents (also called collectors) have been used to adsorb mineral-water interface for flotation.

The aim of this project is to establish a novel sustainable flotation process for extraction of base metals from sulfide ores based on replacement of toxic xanthate derivatives with biodegradable non-toxic lignin nanoparticles. Forest materials will be subjected to organosolv pretreatment followed by a post treatment to convert the lignin fine-particles to nanoparticles. Then organosolv lignin fine particles and nanoparticles will be functionalized by etherification to increase its hydrophobicity. Collaboration with Boliden, with focus on sustainable development, and Sveaskog, Sweden's largest forest owner provides a solid base for developing environmentally benign collectors based on forest biomass.



PRE-STUDIES

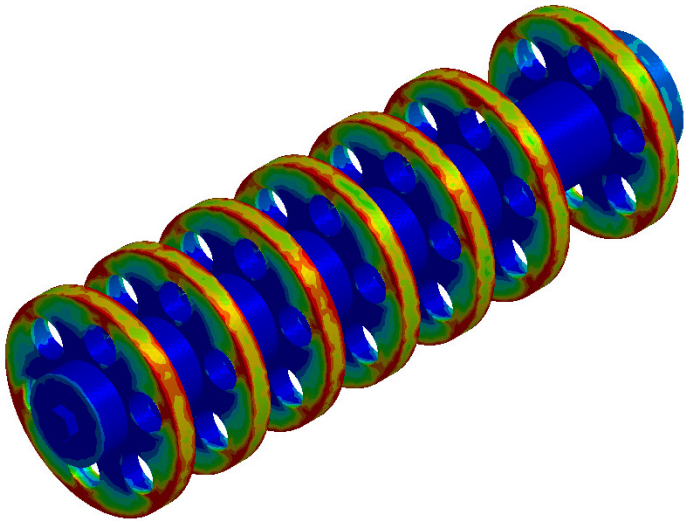
Numerical modeling of blasting and gravitational flow in sublevel caving mines

Project leader: Changping Yi, Luleå University of Technology, changping.yi@ltu.se
Project duration: March–September 2018
Partners: LKAB

The purpose of this project is to improve the understanding of blast-induced fragmentation in SLC mines and the flowability of the fragments. The goal is to develop a numerical model to assess both blast-induced fragmentation in a semi-confined situation and the later gravity flow characteristics of fragments in one model with one solver.

The expected results will comprise a calibrated numerical model for modelling blast and gravity flow in SLC mines in one model, and a modelling-based blast performance and gravity flow assessment method for SLC mines.

The results will lead to one technical report and at least one peer-reviewed journal paper. A workshop will be organized after the project is finished. Based on the pre-study, a full-scale innovation project will be formulated in cooperation with the project partner.



PRE-STUDIES

Stirred media mill performance and grinding wear prediction

Project leader: Pär Jonsén, Luleå University of Technology, par.jonsen@ltu.se
Project duration: March–October 2018
Partners: Boliden Minerals AB, Outotec Sweden AB

With this pre-study we want to close the gap and create possibilities for a future full-scale innovation project. The main scientific objective of the proposed project is to build physically realistic numerical models for grinding of materials in stirred media mills. The aim is to improve the understanding of the internal workings of stirred media mills. The project will be able to estimate possibility to simulate the milling process in a stirred media mill.

The following deliverables are expected:

• Identification of the possible modelling adjustments and experimental data required for model building and calibration,

• Initial results on flow pattern, energy consumption and load intensity distribution in the mill,

• Recommendations for future modelling and validation projects of stirred media mill.

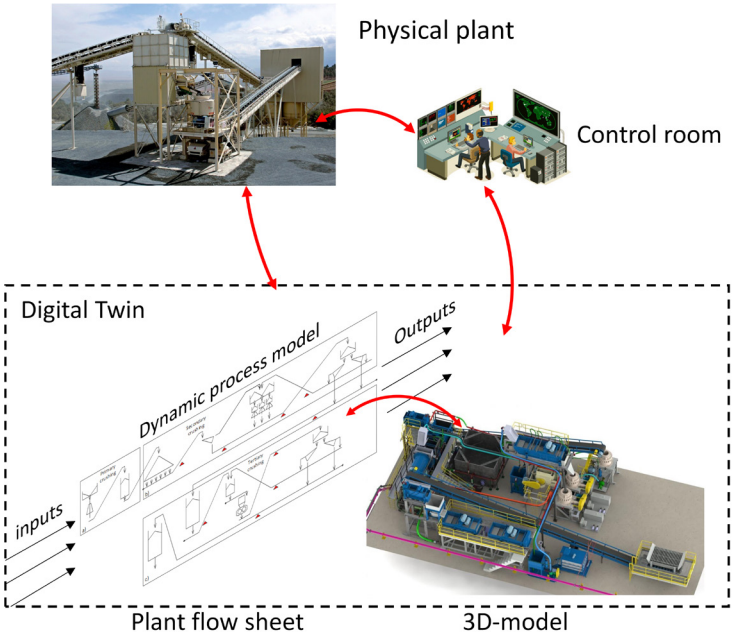
PRE-STUDIES

Digital Mining Hub Bergslagen

Project leader: Pär Lundström, Alfred Nobel Science Park, par@alfrednobelsp.se
Project duration: April–December 2018
Partners: Zinkgruvan Mining AB, Epiroc, Örebro University

Digital Mining Hub Bergslagen will play an important role in switching to more automated and digitized mines. The hub will address the challenges of today and will contribute to increased competitiveness for the Swedish mining industry. Of course, we hope that it will also generate increased focus on the mining industry's relevance in the Bergslagen region and strengthen efforts to launch new mines.

The project will deliver a status analysis of the conditions in Bergslagen. The status analysis will describe the region's strengths and which companies work in the mining industry. The project will discuss with important stakeholders in the region to get a broad understanding of the current situation. The project will also generate a strategy for building a Digital Mining Hub in Bergslagen/Region Örebro. The strategy will also describe the activities and organization of the mining hub as well as how it will be financed in order to meet the goals for the first five years.



PRE-STUDIES

Digital twins for increased efficiency in mineral technology processes

Project leader: Magnus Evertsson, Chalmers University of Technology, magnus.evertsson@chalmers.se
Project duration: April–October 2018
Partners: Boliden AB, ABB AB, LKAB

The aim of this project is to investigate how digital twins can be utilized to improve efficiency in minerals processing circuits and secure long term stable operation as well as continuous development.

A digital twin is a real-time mathematical replica of a physical system implemented in a simulator and can be used for, for example; development of control strategies, evaluating new circuit configurations and assessing overall circuit stability and robustness.

The objective of this pre-study is to answer a number of critical questions that have been identified to be important in order to develop and implement digital twins in minerals processing. These questions are both technical but also organizational in order to answer how to increase the work satisfaction and attractiveness of the workplaces as well as creating a sustainable system. A concept demonstrator of a selected sub-process of a minerals processing plant will be created in order to highlight the key aspects of a digital twin.

PRE-STUDIES

MachineHealth: Towards healthy machines and predictive maintenance with AI

Project leader: Amy Loutfi, Örebro University, amy.loutfi@oru.se
Project duration: April–November 2018
Partners: Alfred Nobel Science Park, Epiroc, Zinkgruvan

In this project we will use established AI algorithms currently from Örebro University together with the data that is available with Certiq (a solution today that provides large scale data from mining machines). The pre-study will evaluate the feasibility of tested AI algorithms to be applied to a new domain to investigate the possibility to provide automated analysis and reveal trends that are not always easily found by human operators. We use established AI methods and seek within this project to understand and outline the necessary prerequisites for these methods to be used in the mining domain by interacting with end-users.

PRE-STUDIES

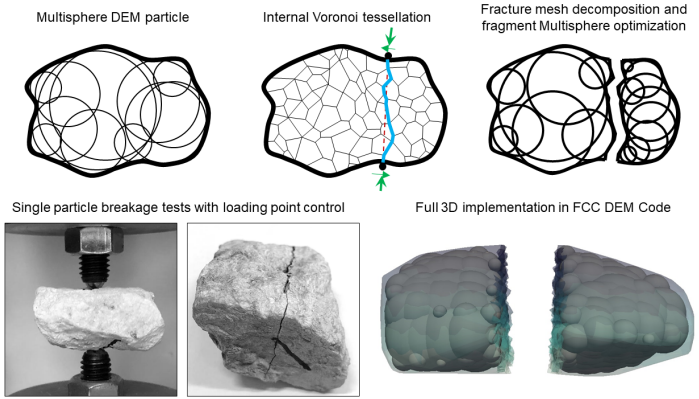
Purification of tellurium using ionic liquid-liquid extraction

Project leader: Johanne Mouzon, Luleå University of Technology
johanne.mouzon@ltu.se
Project duration: June–December 2018
Partners: Boliden Minerals AB

Boliden AB produces tellurium in form of tellurium cement (55% Te) and crude copper-telluride (35% Te) as by-products with low purity from copper production. Purification of tellurium to a purity of 99.999% (5N), necessary for thermoelectric materials and semiconductors, would open up a larger market. Current purification methods are complex and costly with high energy consumption. Development of a technology to extract tellurium with high purity is highly prioritized.

The possibility of reaching a purity of 5N by centrifugal liquid-liquid extraction using 98% tellurium dioxide as feedstock and an ionic liquid (IL) as combined solvent and extracting agent will be investigated. This new method can result in a simpler and more energy efficient process.

The hydrometallurgical process developed will increase the added value of a by-product. The use of an IL with its inherent low vapor pressure instead of volatile and toxic organic solvents will also contribute to no harmful emissions released.



Hybrid model for particle decomposition in DEM

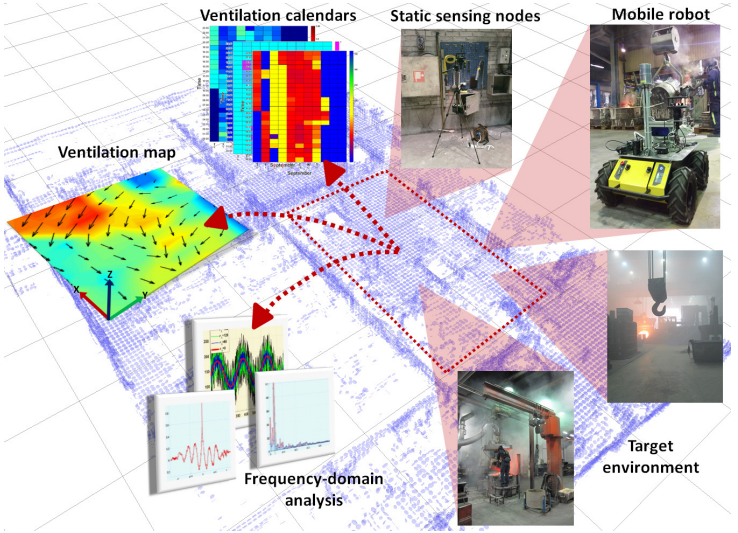
Project leader: Johannes Quist, Stiftelsen Fraunhofer Chalmers centrum för industrimatematik, johannes.quist@fcc.chalmers.se
Project duration: March–November 2018
Partners: Chalmers Univesity of Technology

The project aims to develop a virtual environment for crushing machines on an industrial scale. For systems where particles are crushed, such as in mills and crushers, existing breakage models in DEM have fundamental deficiencies which mean that they are not scalable from lab to industrial environment. Today, one has to choose between either simulating many particles with poor resolution, or few particles with good resolution. A new hybrid model has therefore been formulated that enables the simulation of a large number of particles with accurate fracture behaviour.

The study's first goal is to develop the model from TRL level 2 to TRL 4 and to demonstrate basic functionality and possibilities. The second goal of the study is to carry out a needs analysis and put together a full scale project consortium.

Deliverables and expected results: Validated model in laboratory, Model implemented in software, Experimental results from tests, Consortium and needs analysis.

Long-term utility effects: Improved energy efficiency of crushers and comminution devices, Possibility to evaluate novel innovations in crushing and comminution, Increased operational life of crushers.



PRE-STUDIES

SURVEYOR: Surveying ventilation systems in foundries using robots and stationary sensors

Project leader: Victor Hernandez Bennett, Örebro University,
victor.hernandez@oru.se
Project duration: May–October 2018
Partners: Johnson Metall AB, Global Castings Guldsmedshyttan AB

The goal of the project is to evaluate the feasibility of a novel ventilation surveying system that relies on static sensors, mobile robots and advance statistical modelling.

The outcomes of this project will be the design and construction of a proof-of-concept ventilation surveying system. This proof-of-concept system will be deployed and tested in a foundry hall. The prototype documentation, Analysis and feasibility report, which includes a plan for future developments and commercial oportunities are the deliverables at the end of the project.

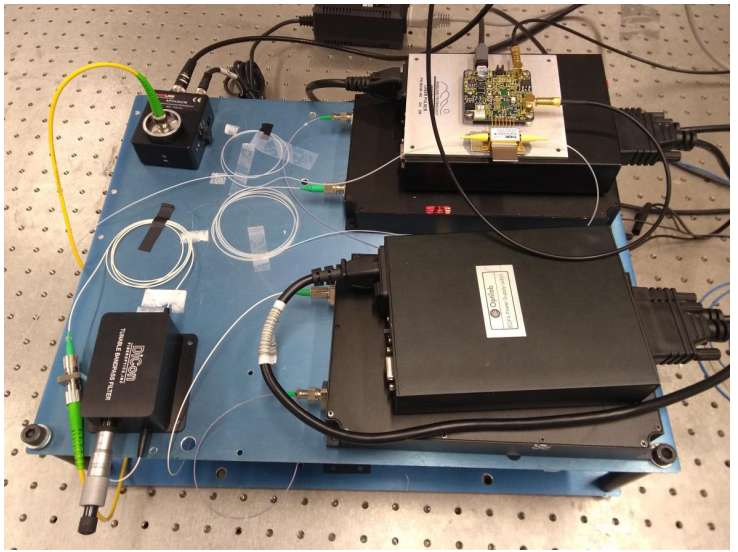
Innovative binders for efficient recycling of steel mill residues

Project leader: Elsayed Mousa, Swerim, elsayed.mousa@swerim.se
Project duration: March–September 2018
Partners: SSAB Merox, Borregaard

The aim is to promote recirculation of steel mill residues by using innovative binders and testing different agglomeration techniques.

Project Goals:
• Promote the recirculation of unexploited steel mill residues by using innovative binders and testing different agglomeration techniques.
• Lowering slag generation and energy consumption by partial/full replacement of traditional binders with novel organic binders.
• Developing agglomerates able to fulfill the specific metallurgical requirements for charging into different iron and steel production units.
• Identification of the optimum agglomeration conditions and techniques for efficient recycling of metallurgical residues.
• Define the optimal pathway for the treatment, agglomeration and application of the metallurgical residues in view of the physical, chemical and mechanical characteristics.

This will show the potential for recycling of fine residues by using innovative binders, minimize landfill materials and maximize valuable metals recovery.

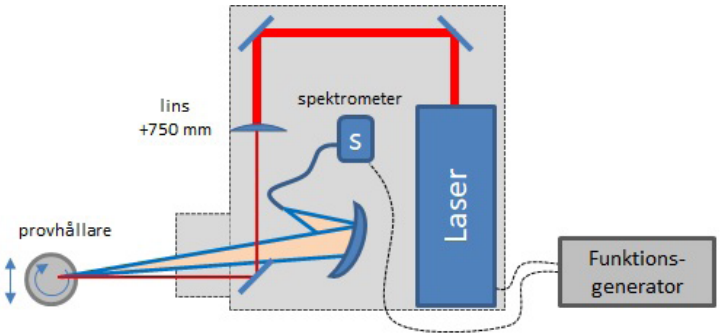


Distributed acoustic optical fiber sensor for conveyor belts health monitoring

Project leader: Carolina Franciscangelis, RISE Acreo AB,
carolina.franciscangelis@ri.se
Project duration: May–November 2018
Partners: RockTech Centre AB

The main aim of the project is to investigate methods to efficiently monitor mining conveyor belts conditions in real time using distributed optical fiber sensors. The project has the goal of verifying the feasibility of employing such sensing methods to detect and localize early stage bearing defects, belt misalignment and delamination, overloaded bearing, resonance events, among other hazardous phenomena, through the analysis of these components acoustic emissions. Another goal is to have reached a good knowledge regarding the commercial potential of the proposed technique and to have performed a plan for a full-scale project aiming at a commercial solution.

The expected results is to have gained a good understanding of the feasibility of a distributed optical fiber sensor capable to detect and localize specified defects in conveyor belts and a full-scale project plan involving this solution.



PRE-STUDIES

On-line monitoring of chemical composition of iron ore with laser-based optical spectrometry (OMLIBS)

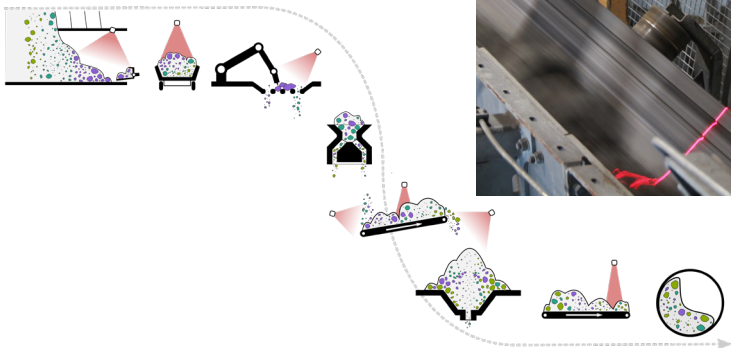
Project leader: Arne Bengtson, Swerim, arne.bengtson@swerim.se
Project duration: March–August 2018
Partners: RISE Acreo AB

The purpose of the project is to devise a fast, cost-efficient technique for real time on-line monitoring of the chemical composition of iron ore, without sample taking and sample preparation.

Project goals:
• Functional technology based on Laser Induced Breakdown Spectroscopy (LIBS) for on-line monitoring of the chemistry of iron ore products in the Swedish mining industry.
• A method of analysis and quantification of LIBS spectra of iron ore products, delivering accurate results with high precision.
• Detailed design specifications for a full-scale prototype system, capable of sustained on-line monitoring of iron ore products in an industrial environment.

Deilverables: A complete LIBS demonstrator for on-line simulation, A calibration method for iron ore, Results of verification analyses, A design specification document for a prototype system

Expected results: The project will provide quantitative data on the expected performance of on-line LIBS monitoring of the elemental composition of iron ore.



STRATEGIC PROJECT

SMIG – Integrated smart testbeds for the mining industry

Project leader: Anders OE Johansson, Nordic Rock Tech Centre AB, anders.oe.johansson@sip-piia.se
Project duration: Phase one 2017–2018, Phase two 2018–2020
Partners: Boliden AB, LKAB, Atlas Copco, Sandvik, Volvo CE, ABB, Ericsson, IBM, BnearIT, DataDuctus, Mobilaris. Optimation, Oryx Simulations, Algoryx Simulations, Bergteamet, SKB Äspö, Luleå University of Technology, Umeå University, UMIT Research Lab, Uppsala University

SMIG is a joint project between SIP STRIM and SIP PiiA. The project will run four years and is a result of the Swedish government's initiative *Innovation partnership programmes* and the programme *Connected industry and new materials.*[1] In SMIG, mining companies, suppliers of mining equipment and systems, specialised SMEs, universities and institutes will together develop a test bed based on various existing, ongoing and new test initiatives that will be integrated and the testbed will also be demonstrated in a number of use cases. The SMIG testbed is for test and demonstration of intelligent mining technologies supporting innovation that are need for the mining industry in the future.

[1] http://www.government.se/articles/2016/07/innovation-partnership-programmes--mobilising-new-ways-to-meet-societal-challenges/

STRATEGIC PROJECT

Zero base measurement and sustainability database

Project leader: Håkan Tarras-Wahlberg, Swedish Geological AB,
hakan.tarras-wahlberg@swedishgeological.com
Project duration: 2017–2019
Partners: Luleå University of Technology

The purpose of the project is to build a sustainability database covering the Swedish mining industry and measure a zero-base of the effects of the SIP STRIM programme in relation to the programme's outcome goals. Expected results are a sustainability database and completed zero-base measurement of the SIP STRIM programme.

STRATEGIC PROJECT

MINDI Mining industries data initiative

Project leader: Johan Hedlin, Nordic Rock Tech Centre AB,
Project duration: 2017–2019
Partners: LKAB, Boliden, Epiroc, Luleå University of Technology

The projcet aims to help mining companies and their machinery and system vendors contribute to increased mining productivity by developing knowledge and promoting the application of a computerised approach, such as to carry out faster and more accurate monitoring of processes and subprocesses, with increased quality. The result should be shorter lead time from event to action and faster access to accurate data at the right time and place for the organisation. At the end of the project, participating mining companies will have developed a strategy and architecture for managing data in their organisation. Participating companies have increased their knowledge and understanding of how to utilise their data resources, enabling them to streamline their business. Richer and continuously updated geological models provide a better understanding of the rock and ore body. All stakeholders will benefit from well-described principles for how data can be exchanged and who owns data, business principles, etc. between different organisations.

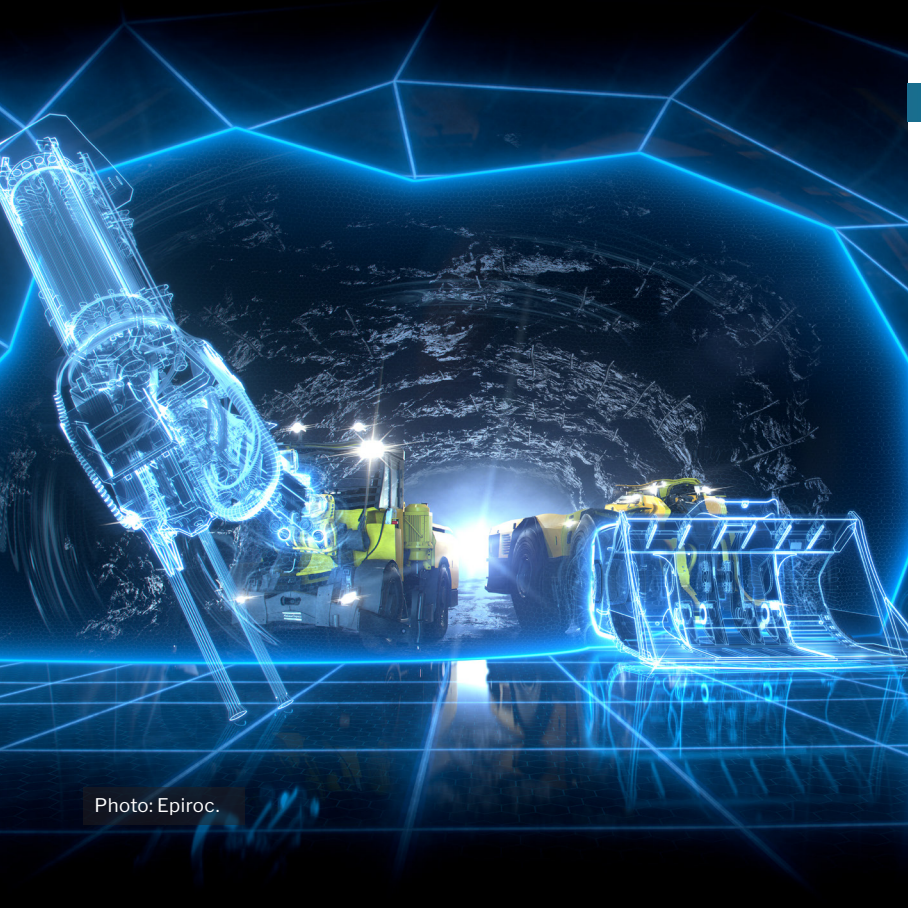


Photo: Epiroc.

STRATEGIC PROJECT

Roadmap for a fossil-free mining and mineral industry

Project leader: Erika Skogsjö, Svemin, erika.skogsjo@svemin.se
Project duration: 2017–2019
Partners: RISE

The aim of the project is to support the Swedish mining, metals and mineral producing industry in its goal of being fossil-free in 2045. The roadmap will help define and set milestones for the investments, technology development, and critical supporting conditions in society needed to complete the transition. The industry, with support from research and project management partners, will undertake a participatory process to establish the current status, describe the future vision for the industry, and specify the development pathways for crucial innovation areas such as mining equipment, vehicles, and processing of ores. Outputs from the Roadmap process will contribute to the cross-industry initiative Fossil-Free Sweden, and the final Roadmap will be the basis for ongoing work both within the industry and with stakeholders and partners in society.

Photo: Gustaf Anderson, Svemin.

STRATEGIC PROJECT

Exploring alternative sustainable futures for the Swedish mining industry

Project leader: Erika Skogsjö, Svemin, erika.skogsjo@svemin.se
Project duration: 2017–2019
Partners: Stockholm Environment Institute

The purpose of the project is to highlight the role of the mining and mineral producing industry in society's sustainable social transformation. This is done in a co-creation-process together with various relevant stakeholders in society, analysing the importance of a more sustainable mining and mineral producing industry in a sustainable society and the challenges and opportunities the sector and its customers are faced with. The goal is more systemic knowledge of the role of the future mining and mineral industry can play in the transition to a sustainable development, and based on that a strategic activity programme which will let the sector contribute even more to a sustainable social development. The project is run by Svemin and SEI, with participation from both industry and relevant community actors and stakeholders. The expected effects are that the mining and mineral industry should be able to contribute even more to society's sustainable transformation, and all the 17 goals in the UN sustainable development agenda.

STRATEGIC PROJECT

Traceability – for sustainable metals and minerals

Project leader: Frida Höjvall, RISE, frida.hojvall@ri.se
Project duration: 2018–2019
Partners: Svemin, Luleå University of Technology, Boliden, LKAB

The main objective of the project is to present possible processes for traceability that relevant stakeholders will review and, based on the conclusion, select a feasible process that is appropriate and meets the requirements on a transparent and trustworthy traceability system.

The project will analyse how chain of custody models and approaches can be developed, with support from modern technology, for tracing the life cycle journey of copper. It will describe the properties that can be traced by the different models and compare implementation requirements in terms of costs, tracing procedures and market acceptance. To ensure the trust on the market and protect the certificates from falsification, the applicability of blockchain technologies will be investigated. Copper is chosen as a first user case in this project because the metal is mined in Sweden and is an export metal. The goal of the project is to have stakeholders agree on a concept ready to be tested in a pilot study as a next step.

STRATEGIC PROJECT

Roadmap for competence supply

Project leader: Jesper Hedin, Svemin, jesper.hedin@industriarbetsgivarna.se
Project duration: December 2018-July 2019
Partners: Jernkontoret, Industriarbetsgivarna

The project aims at developing a roadmap for competence supply for the Mining and, steel and metal producing industries. The roadmap will describe present state, future needs and give directions for future actions in order to meet the industries needs of competence.

The most important short term result is a better basis for decision-making regarding actions and activities by a clearer picture of needs and priorities. The results are also an important input to the R&I proposition later in 2019 and will aslo be a basis for activities in SIP STRIM and SIP Metalliska Materials coming program periods. The most important long term effect is competence supply.

PILOT PROJECTS

Improved resource efficiency through dynamic loading control II
Project leader: Anna Gustafsson, Luleå University of Technology, anna.gustafson@ltu.se
Partners: Agio system och kompetens i Skandinavien AB, LKAB
Project duration: June 2019-November 2020

FULL-SCALE PROJECTS

Automated drill planning for multiple-boom rigs in underground mining
Project leader: Federico Pecora, Örebro University, federico.pecora@oru.se
Partners: Alfred Nobel Science Park, Epiroc Rock Drills AB, Zinkgruvan mining AB
Project duration: May 2019-April 2022

Organosolv lignin hydrophobic nanoparticles as low-carbon-footprint biodegradable flotation collectors
Project leader: Ulrika Rova, Luleå University of Technology, ulrika.rova@ltu.se
Partners: Akzo Nobel Surface Chemistry AB, Boliden Mineral AB, Sveaskog förvaltnings AB
Project duration: May 2019-April 2022

SO4-BIORED Demonstration of biological sulfate reduction in cold climates
Project leader: Karin Willquist, RISE Research Institutes of Sweden AB, karin.willquist@ri.se
Partners: Boliden Mineral AB, Fortum waste solutions AB
Project duration: March 2019-November 2020

Optimized roasting of complex copper sulphide concentrates for flexible raw material utilization
Project leader: Caisa Samuelsson, Luleå University of Technology, caisa.samuelsson@ltu.se
Partners: Boliden Mineral AB (Smelters and Mines), SEMTECH Metallurgy AB
Project duration: April 2019-March 2022

PRE-STUDIES

Digital driver support for interaction between vehicles in mining environments
Project leader: Anna Sirkka, RISE Research Institutes of Sweden AB, anna.sirkka@ri.se
Partners: Epiroc Rock Drills AB, Mobilaris AB, Scania CV AB
Project duration: April-September 2019

Developing a numerical tool to optimise mining sequences and minimize seismic hazard using mine stiffness concept
Project leader: Phing Zhang, Luleå University of Technology, ping.zhang@ltu.se
Partners: LKAB
Project duration: May-November 2019

Platinum-group elements in Swedish Ni-Fe-Cu sulfides
Project leader: Thomas Aiglsperger, Luleå University of Technology, thomas.aiglsperger@ltu.se
Partners: University of Barcelona
Project duration: April-September 2019

Energy Efficiency in Rocks Comminution using High Power Microwaves
Project leader: Dragos Dancila, Uppsala University, dragos.dancila@angstrom.uu.se
Project duration: March-September 2019

Distance, Awareness and Orientation: Exploring augmented reality applications for the deep mining industry
Project leader: Anna Karlsson, Boris Design Studio AB, anna@borisdesignstudio.com
Partners: Mine Tec, RISE Research Institutes of Sweden AB
Project duration: March-August 2019

Efficient metalpowder process with innovative sensor technique
Project leader: Erik Zetterlund, RISE Research Institutes of Sweden AB, erik.zetterlund@ri.se
Partners: Höganäs AB
Project duration: March-August 2019

GRÄV - mining value change
Project leaders: Julia Jonasson, RISE Research Institutes of Sweden AB, julia.jonasson@ri.se
Partners: Karlstad Innovation Park, Sticky Beat AB, Up is down AB, Voestalpine precision strip AB
Project duration: June-November 2019

Recovery of Lithium from dust generated in pyrometallurgical treatment of Li- ion batteries
Project leader: Lena Sundqvist, Luleå University of Technology, lensun@ltu.se
Project duration: March-August 2019

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