Environmental performance

Summary/purpose of the thematic area

The vision for the Swedish extractive industry is that metals and minerals producted are certified and labeled as sustainably produced and the Swedish Society is proud of its extractive industry, attracting highly qualified professionals from all over Sweden and around the world to work in industrially diversified, attractive mining cities. The Swedish mining industry has to face new challenges in the future in order to maintain its high competitiveness on the world market, climate change and tougher environmental directives and legislations. However, new opening of mines is crucial to maintain a sustainable growth of the society, welfare as well as for the industry sector in a mining country like Sweden, and especially in the northernmost part of Sweden. New EU Directives adopted in Swedish legislation, set new target values for waste management and emission of waters from mining operations for emerging pollutants for example nitrate, uranium and sulfate. As Sweden is located in cold/temperate to arctic climates, which are of the most vulnerable to climate change, all aspects of the mining process have to be under the light of a change of the climatic conditions in the future. Additionally, there are new challenges like the classification and traceability of sustainable production and social and environmental performance, as the end-users are more and more aware of the impact of metal production on the environment. Therefore, a sustainable waste and water management must be integrated in the management of a mine, and waste and water issues included in all operations phases from exploration, mining, mineral processing and metallurgy to reduce and prevent that wastes constitutes a source for pollution and extraordinary land use.

Thorough characterization and separation of different mineral groups, higher degree of mineral and metals in wastes can be transformed into benefit products, and the remnants stored safely or be prepared for later use. This require that it is a market available for products, and that the processes are effective and the management of the remnants sustainable. A sustainable waste and water management needs a holistic view, meaning that assessments of consequences and impact on the environment needs to be included in development of new systems and processes. Not all changes of processes will lead to improved environmental performance, but can rather lead to the opposite, which should be addressed before changes in process takes place. This means that environmental prediction and risk assessment and interdisciplinary research over the value chain is necessary, but also interdisciplinary research within the environmental sector can enhance the environment performance. Due to these challenges, there is a need of increased knowledge of biogeochemical and mechanical processes in mine waste and water, and new sustainable and effective management and treatment methods need to be developed. Early in the mining operation phase, the benefit for the society and eco remediation after closure should be assessed, such as sculpturing of the landscape, improved biodiversity.

The air emission and energy consumption must be reduced and knowledge on CO_2 captured should be developed by research. Mining is temporary land use, therefore, post mining landforms and landscapes should serve future benefit and added valued for Swedish society. This should be included in the early phase of the mining, and be part of the remediation measures. The mining industry will also in the future contribute to the local, indigenous and national communities and are desirable activities and assets within these communities.

Objectives and KPI

Overall aim

Prevent emissions to air, water and environment
Prevent impact on the environment and extraordinary land use
Traceability and transparence of sustainable production and environmental performance

Main challenges for the Swedish industry related to environmental research

Competitiveness on the world market
Gain the license to operate, land use conflicts
Restricted environmental directives and legislation for target constituents
Cold/Arctic climate
Climate changes (reduce carbon dioxide emission, increased precipitation, more fluctuating cold and warm periods)

Specific objectives;

Control of pollution source, pathway and impact on recipient
Increase the resource efficiency leading to reduction of storage wastes
Safe mine waste facilities
Control of waste streams and pollutions sources
Increase interdisciplinary research
Attract young talents to the mining sector

Research and innovation needs, strategies and actions

The research related to environmental performance of mines should be assessed in a holistic view of the waste and water management to optimize long-term sustainable solutions.

Water: The environmental protection demands from directives like EU (e.g. 2000/60/EU and 2008/105/EU), adopted in Swedish legislation and sets targets for chemical and ecological environment status. Methodology needs to be developed for site specific baseline studies of soils and water bodies and functioning of the ecosystem before, during, and after mining activities. Mineralogical characterization, isotopic studies, trace elements biogeochemical cycling, interactions, reliable prediction and geochemical modeling are important tools and parameters to trace and control the water quality and flow from the source to the final discharge into the natural environment and its environmental impacts downstream. The effects of these discharges have to be evaluated in the light of the predicted climate change for the Swedish conditions.

For holistic view of the water source, pathway and impact, it needs multidisciplinary research along the value chain (WP in this agenda), monitoring system and proper data management system. The water consumption has to be minimized in the process through for example increased recycling, which requires proper water treatment technologies and on-line monitoring to control of water flow and quality. Due to more restricted legislation specific treatment systems for specific elements such as N, S and U needs to be developed. The treatment systems can be either passive (e.g. wetlands, drains, barriers) or active (chemical reagents).

Wastes:

The overall aim of the agenda is to increase the resource efficiency leading to reduction of wastes that need storage. Methodologies to identify, quantify, estimate and evaluate the benefits and improvement of ecological compensation.

Improved mineralogical and geochemical characterization of the ore and wastes enables possibilities to improved separation of minerals into parts that are in need of higher degree of safe storage (reactive minerals elements of concern, fine particles which cannot provide stability in further use) while other parts (non-reactive) can be used as resource for instance as cover material, road construction etc. This research has to be in collaboration with other parts of the value chain. Non-reactive geo-resources used as resources need careful characterization and its long-term durability evaluated. For reactive wastes, new innovative cost effective stabilization techniques, ecological remediation, cover and encapsulation materials and systems need to be developed, and theirs long-term durability on the ecosystem evaluated. The long-term benefits of mine closure and sustainable landscape design and remediation measures should be taken into account as well as added value after closure, of the site, improved biodiversity.

Short term and long term stability of waste facilities requires proper characterization of theirs mechanical properties and behavior to be able to develop alternative depositions techniques for instance dry stacking, thickened or paste tailings. The dam designs and construction of tailings impoundments have to be improved, tested and modeled to predict the behavior in cold climate and in changing climatic conditions. Integration of geotechnical and geochemical characteristics and behavior in cold climate is necessary to secure a waste storage facility. The benefits for stability of wastes due to cold climate should also be invested. In addition the effect of man made or natural seismicity, heavy rainfall and other climatic changes needs to be considered as they might lead to unknown or not considered failure modes (Ice lenses, static liquefaction:Dust generated from mining operations and during loading, transport and handling of minerals and solid by-products can constitute a significant source of particles and lead to harmful exposure of workers as well as inhabitants in the vicinity. Improved methods for

characterization, preventing, monitoring and modelling of emissions and dispersions need to be developed as well as cost-effective measures to prevent dust generation and exposure.

Emissions to the air, for instance carbon dioxide has to be minimized and technologies for capturing of carbon dioxide need therefore to be developed

Short term:
Development of automated quantitative mineralogical and geochemical characterization methods
Development of specific water treatment system for target elements such as N, S, U
Development of methodology for baseline studies of the environment
Development of cost-effective covers material and systems
Development of eco-remediation methodologies
Development of biogeochemical and mechanical characterization of wastes and water
New assessment methodologies for impacts on health and biota (e.g. DNA)
Stability assessment of tailings construction to loading scenarios caused by climate change and man made seismicity

Medium term:
Development of cost-effective passive treatment systems (wetlands, barriers)
Development of new products from non reactive minerals

Long-term:
Evaluation and control of persistent and efficiency of cover system
Development of monitoring system of wastes and water quality and behavior, automatization and digitalization?

Expected impact
Overall expected impact
Sustainable mine waste and water management that reduce the emission to the environment

Specific expected outcome
- Developed water treatment and monitoring system for specific elements
- Understanding of biogeochemical cycling of specific elements in wastes and water systems
- Methodology of eco remediation
- Sustainable and cost-effective cover materials and new innovative cover system established
- Methods to estimate and utilize eco compensation
- Control of and safe waste storage facilities
- Control of environmental and health impact
- Holistic view of waste and water management
- Improved and realistic legislation
- Induced interdisciplinary research