Mine Waste Management Methods – improving material recycling and decreasing waste – KaiHaMe project

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Background

• Management of mining wastes is one of the primary challenges of sustainable mining.
• Only a small part of excavated metal ores can usually be utilized and the rest of the material is disposed as a mineral waste.
• The uncontrolled drainage from waste disposal sites may deteriorate downstream water bodies and cause harm to aquatic biota and human health.
• The KaiHaMe project develops tools for the utilization and management of mining wastes and for the prediction of their discharge quality.
Mining Waste Management Methods (KaiHaMe)

• Main themes:
  • Optimization of mine waste characterization and utilization, identification of raw material potential of wastes
  • Long term stability and storage of wastes
• Duration: 1.5.2015–31.12.2017 (2 y 8 m)
• GTK Industrial Environments and Recycling Unit Kuopio and GTK Mineral Processing and Materials Research, Outokumpu and Espoo
• FQM Kevitsa Mining Oy = Boliden Kevitsa (since June 2016), Kemira Oyj, Endomines Oy
• 580 k€, ERDF funding (60 %)
Objectives

- To decrease negative impacts of mining waste disposal and to promote sustainable mining by enhancing material eco-efficiency throughout the life-cycle of mining operation
- To increase raw material value of excavated ores
- To decrease the amount of disposed hazardous waste
- To enhance the prediction of long-term impacts of wastes
- To strengthen the network of mining competence in Eastern Finland
Approaches

• To develop an operational model for the optimal use of wastes to enhance material eco-efficiency (WP1). The model will combine raw material aspects and environmental characterization of wastes.

• To review data on modelling tools applied in the prediction of waste effluent quality and make a suggestion of respectable methods (WP2).

• To study how to optimize the use and environmental properties of wastes through beneficiation (WP3).

• To seek new options for the use of non-inert waste rocks at mine sites (WP3).

• To disseminate generated knowledge through workshops, publications and Wiki (WP4).
Benefits of the KaiHaMe project

- Improved operational preconditions for sustainable mining
- Improved management of mining wastes
- Increased material ecoefficiency and decreased use of other natural resources
- Decreased negative impacts of mining waste disposal
Project structure

**WP1** Operational model for optimization of mining wastes

**WP2** Long term stability of mining wastes and prediction of seepage water quality

**WP3** Increased utilization and raw material potential through processing of mining wastes

**WP4** Dissemination and communications
Operational model for optimization of mining wastes

• Operational model to be developed will combine data/knowledge from benefications tests and pilot processing with environmental characterization
  – To identify raw material potential of wastes
    • Valuable metals, valuable minerals, utilization potential
  – To assess environmental risks related to wastes as early as possible
    • Presence and occurrence/form of harmful elements, their mobilization potential, AMD potential of wastes
Model for optimization of tailings properties and characterization

• To provide mining operators comprehensive characterization of the ore and wastes in one go
  – Adaptation of the beneficiation process to gain more value of the ore and to decrease amounts and environmental risks of wastes
  – Characterization of environmental properties of wastes for waste management and to evaluate costs

• Basis for the model
  – Legislative requirements for characterization; standards, guidance
  – GTK resources and facilities – current procedures
  – Evaluation of subcontracting needs
  – Mining operators’ expectations
Operational model for optimization of mining wastes

Beneficiation tests → Pilot-tests

Waste materials → Process water

Mineralogical investigations → Geochemical analyses → Radiological analyses

Evaluation of raw material potential → Assessment of environmental properties

Adapting enrichment process

Optimized mineral processing → Comprehensive environmental characterization of tailings and process water

New products → Less hazardous waste

GTK

Subcontractors
Long term stability of mining wastes and prediction of seepage water quality

• Review of available methods for the prediction of effluent quality and their usability in Nordic conditions

• A proposal of suitable modelling tools
  – Testing the selected tools with data from various mine sites in Finland (seepage water and waste characteristics)
    • Closed/abandoned mine sites & operating mine sites
    • Base metal mines & industrial mineral mines
    • Previously collected data complemented with data collected in KaiHaMe
    • Comprehensive characterization of wastes and seepage waters
Increased utilization and raw material potential through processing of mining wastes

• To promote multipurpose use of mining wastes
  – by developing evaluation of raw material potential of wastes,
  – by modifying wastes into more usable form,
  – by finding new usage options for wastes, and
  – by evaluating environmental performance of modified wastes

• Task 1: Enhanced processing of tailings containing harmful elements

• Task 2: Increased potential of the use of waste rocks in earth construction of a mine site
Enhanced processing of tailings containing harmful elements

- To assess economic ways to process/modify wastes one step further
- To decrease contents of harmful elements in wastes
  - To increase utilization potential of tailings, and
  - To decrease the amounts of hazardous wastes
- Beneficiation tests carried out on As-containing tailings
  - 3 different ore types (Kopsa, Kuikka-2)
  - Grinding tests, flotation tests, testing of different chemicals
  - Objective: to decrease As levels in the wastes
  - Detailed mineralogical and geochemical characterization of the tailings and process waters carried out
Enhanced processing of tailings containing harmful elements

- Filled-in-lysimeter tests applied to evaluate environmental performance of the modified tailings
  - Possible use in cover structures on other tailings materials
  - Comparison of original As-rich tailings with modified, As-poor tailings
  - Empty control lysimeter
  - Water sampling from the lysimeters carried out

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Increased potential of the use of waste rocks in earth construction of the mine site

- Filled-in-lysimeter tests are carried out to evaluate leaching of harmful elements from waste rocks
  - Influence of grain size
  - Use as a cover material on top of other waste rock
  - Three different waste rocks tested
    - Hitura serpentine & mica gneiss
    - Kevitsa olivine pyroxenite
    - Empty control lysimeter
Increased potential of the use of waste rocks in earth construction of the mine site

• Hitura:
  – Mobility of harmful elements in mica schist and serpentinite; consequences of “disturbing” old waste rock piles?
  – Utilization of the Ni-containing serpentinite as a cover in the closure of the mice schist pile

• Kevitsa:
  – Mobility of harmful elements from aggregate; potential for using the aggregate also outside the mine site?
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http://projects.gtk.fi/KaiHaMe/index.html