

Business from technology

Water Conscious Mining - Wascious

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norden

NordMin



Background

Need to close the loop in water management

- Water in mining has been a commodity for intake and discharge at will – water recirculation and **treatment has not been thoroughly incorporated into process** and mine design
- Analogies from pulp and paper industries show that water intensive, flow-through industries **can change into small water footprint** design
- This requires rethinking of
 - 1) management of fresh water intake and **drainage** from pits, waste rock piles and tailings,
 - 2) **process water** recirculation and management,
 - 3) **water treatment** options and
 - 4) proper **treatment of tailings**
- Taking hold of advanced mining water issues by aiming for a short retention time in-line treatment and recycling will give Nordic research a competitive edge for future development

Project: Water Consious Mining - Wascious

- Financier: NordMin and participating partners
 - The NordMin programme is one of the top priorities in the Nordic budget, introduced by Sweden during its Presidency in 2013. The aim is to develop the Nordic mining and mineral industry in sustainable way for increased competition and growth.
- Budget: 7.98 Mill. DKK
- Timetable: 1.4.2014 - 30.9.2016
- Project coordinator: Margareta Wahlström, VTT, Finland



Consortium

Research organizations:

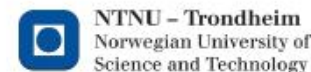
VTT Technical Research Centre of Finland
 LUT Lappeenranta University of
 Technology, Finland
 Sintef, Norway
 NTNU, Norway
 Luleå University of Technology, Sweden
 ÍSOR Iceland Geosurvey. Iceland

Solution providers:

Veolia, Denmark
 Outotec (Finland) Oy
 ÅF Consult Ltd

End-users:

FQM Kevitsa Mining Oy, Finland
 Dragon Mining Ltd, Finland
 LKAB Luossavaara-Kiirunavaara AB,
 Sweden
 FinnMin - Finnish Mining Association
 SveMin - Swedish Association of Mines,
 Mineral and Metal Producers



Overall objectives

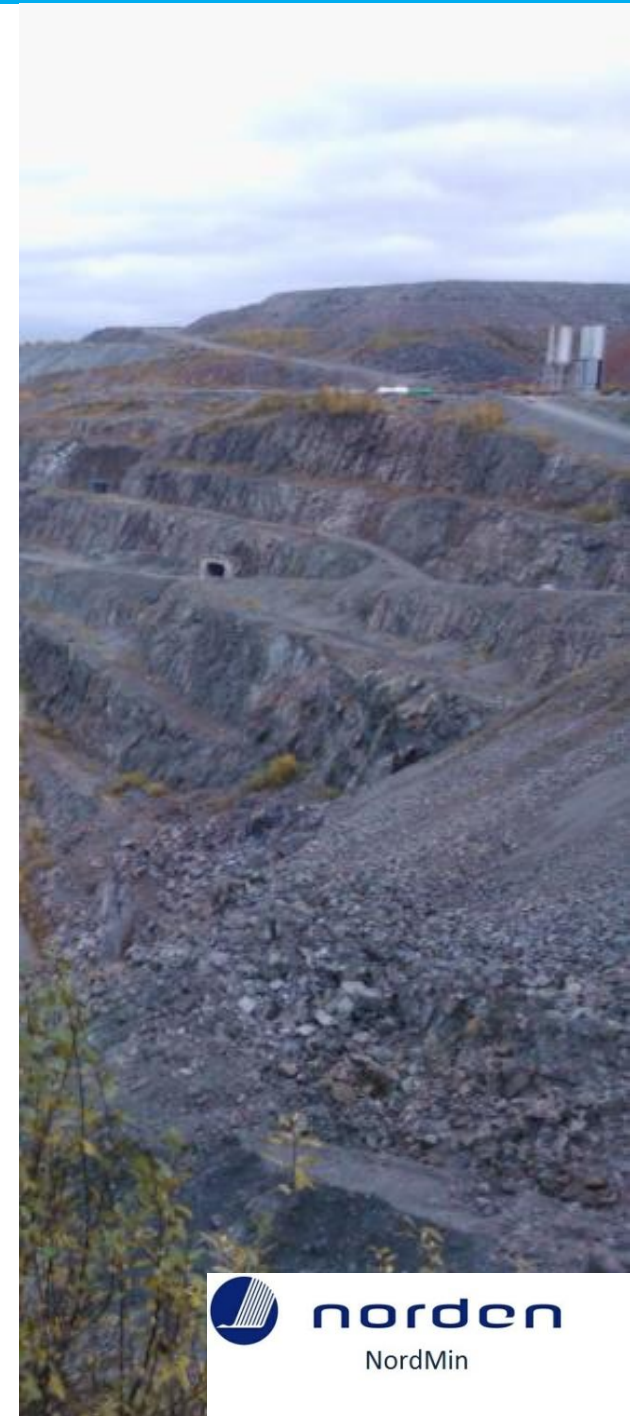
- Development of a **technology concept for water conscious mining**, where *innovative waste and water treatment using suitable customized technologies provides good-quality water for recycling and enables safe utilisation or disposal of tailings.*



Photo: Samrit Luoma

Project components

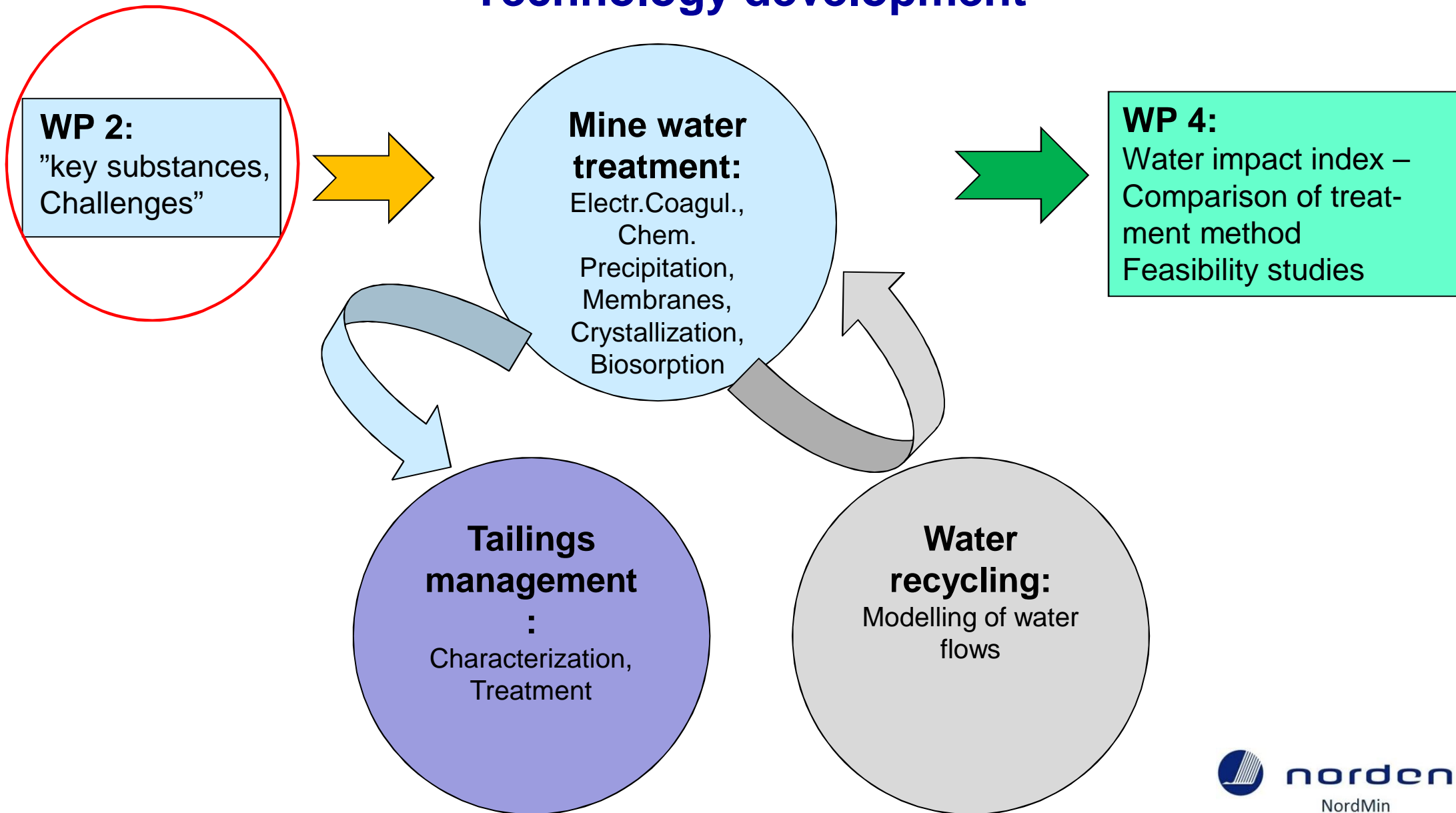
- **Survey of current practices**, their economic and environmental burdens and resources available for alternative practices
- **Requirements** for recycled and discharged waters, tailings quality (utilisation, disposal)
- **Identification and evaluation of key technologies** for distributed water management, process management, tailings treatment and water treatment
- **Research and development of novel technologies** for dewatering of tailings, process and effluent water treatment aiming at in-line treatment and minimum fresh water intake. Novel technologies in this project will focus mainly on electrochemical treatment methods combined in an efficient way with other existing methods (membranes, chemical precipitation, solid/liquid separation etc.
- **Development and evaluation of the concept**
- **Plan and actions for continuation**



Project implementation

	Title	Task leader	Description
WP1	Project management	VTT	Project coordination
WP2	Current practices and related environmental issues	VTT	Survey of current practices in Nordic mines, identification of areas of concern
WP3	Technology development	LUT	Development and testing of new treatment technologies for mine water and wastes
WP4	Water conscious mine-concept	Veolia	Development of concept for low-water footprint
WP5	Future research platform	LTU	Establishment of R&D network related to environment issues in mining, future project calls
WP6	Dissemination	VTT	Sharing findings with all partners involved in mining

Technology development



WP2 –tasks

Task	Contents	Execution
2.1 Present status at Nordic metal mines	<ul style="list-style-type: none">• Current water intake and discharge quantities and qualities• Limit values for contaminants in effluents• Water recycling rates• Current water treatment processes and efficiencies• Current solid waste management practices	<ul style="list-style-type: none">• Template for data gathering was circulated• Data (mainly from Sweden and Finland) has been collected• VTT to draft a report on current practices
2.2 Identification of key challenges	<ul style="list-style-type: none">• Based on previous task, e.g. key substances in mine effluents are identified• Input to experimental work in Work Package 3	<ul style="list-style-type: none">• Decisions during meetings
2.3 Evaluation of available technologies for mine water treatment	<ul style="list-style-type: none">• Industrially available water treatment technologies	<ul style="list-style-type: none">• VTT to draft a state-of-the-art report

Examples of findings from Wascious WP2 – Regulations for water quality (Sweden)

Mine	Details	Waste water discharge, Mm ³ /a	Regulated substances and limit values	Current discharge
Aitik (SWE)	Cu, Au sulphide ore, Open pit mine	Process water from clarification pond 8,4	Cu: 270 kg/a	46 kg/a
Björkdal (SWE)	Au ore, open pit & underground mine	1: Mine water 0,58 2: tailings pond 0,30	SS: 15 mg/l	14,6 mg/l (1)
			NO ₃ -N: 20 mg/l	21,7 mg/l (1)
			NO ₂ -N: 0,2 mg/l	0,49 mg/l (1)
Garbenberg (SWE)	Zn, Pb, Cu, Ag, Au sulphide ore, underground mine	Discharge from tailings pond 2,5	SS: 10 mg/l	2,6 mg/l
			As: 40 µg/l	7,8 µg/l
			Cd: 1 µg/l	0,4 µg/l
			Cr: 5 µg/l	0,7 µg/l
			Cu: µg/l	18 µg/l
			Pb: 40 µg/l	5,3 µg/l
			Zn: 300 µg/l	103 µg/l
N tot: 10 mg/l	6,0 mg/l			
Kankberg (SWE)	Au, Ag, Te sulphide ore, underground mine	Mine water 0,31	N tot: 15 mg/l	47 mg/l
			As+Cu+Pb+Zn: 1 000 µg/l	96 mg/l
Kristineberg (SWE)	Zn, Cu, Pb, Au, Ag sulphide ore, underground mine	1: Mine water 0,89 2: tailings pond 1,9	SS: 10 mg/l	8,0 mg/l (2)
			Zn: 1 000 µg/l	229 µg/l (2)

Examples of findings from Wascious WP2 – Regulations for water quality (Finland)

Mine	Details	Waste water discharge, Mm ³ /a	Regulated substances and limit values	Current discharge
Kittilä (FIN)	Au sulfide ore, underground mine	1: Mine water 1,7 2: Process water from tailings pond 0,86	SS: 10 mg/l	2,0 mg/l (1), 10 mg/l (2)
			SO ₄ : 2 000 mg/l	640 mg/l (1), 8 900 mg/l (2)
			As: 0,5 mg/l	0,06 mg/l (1), 0,09 mg/l (2)
			Sb: 0,5 mg/l	0,21 mg/l (1), 0,04 mg/l (2)
			Ni: 0,3 mg/l	0,16 mg/l (1), 0,05 mg/l (2)
			N tot.: 30 mg/l	10,9 mg/l (1), 24,1 mg/l (2)
			WAD-cyanide: 0,4 mg/l	0,017 mg/l (2)
Pyhäsalmi (FIN)	Zn, Cu sulfide ore, underground mine	Water from clarification pond 6,9	SS: 10 mg/l	5,8 – 7,5 mg/l
			Cu: 0,2 mg/l	0,03 – 0,04 mg/l
			Zn: 1,0 mg/l	0,08 – 0,17 mg/l
Kevitsa (FIN)	Ni, Cu sulfide ore, open pit mine	Water from clarification pond 1,8	SS: 10 mg/l	1,7 mg/l
			Cd: 10 µg/l	<0,1 µg/l
			Cu: 100 µg/l	3,8 µg/l
			Hg: 5,0 µg/l	-
			Ni: 300 µg/l	104 µg/l
			SO ₄ : 2 000 mg/l	377 mg/l
Pampalo (FIN)	Au ore, underground mine	Water from tailings pond 0,5	SS: 20 mg/l	Not known
			Ni: 1,0 mg/l	Not known

Examples of findings from Wascious WP2 – Current water treatment practices (Finland)

Mine	Details	Water treatment operations	Volume of treated water (Mm ³ /a)	Performance characteristics
Kittilä (Finland)	Au sulfide ore, underground mine	<ul style="list-style-type: none"> Cyanide destruction from cyanide leaching process water. Water from flotation tailings pond and mine water to overflow wetlands, after which they are discharged to a river. 	0,86	Removal efficiencies ¹ : SO ₄ 10 %, As 98 %, Sb 84 %, N tot. 60 %
Pyhäsalmi (Finland)	Zn, Cu sulfide ore, underground mine	Liming of water, settling at tailings and clarification ponds. Aeration of effluent at winter time	6,9	Not known
Kevitsa (FIN)	Ni, Cu sulfide ore, open pit mine	Liming of water in flocculation tank, clarification pond, optionally neutralization after clarification (sulfuric acid)	1,8	Not known
Pampalo (FIN)	Au ore	Clarification at tailings pond	0,5	Not known

Summary from data collection on current practices (1): Water quality and regulations

- Concentration of suspended solids (SS) are regulated at almost every site in Sweden and Finland
 - Clarification ponds
- Metal mines in Sweden have lower limit values for metal concentrations in mine effluents than Finland
 - Does not however seem critical, as the effluents seem to fulfil the current criteria
- Nitrogen appears to be more often regulated at Swedish sites
- Sulphate has been regulated at a couple of sites in Finland, but not at Swedish sites

Summary from data collection on current practices (2): Water treatment

- Clarification ponds for the removal of suspended solids are the main water "treatment" method at Nordic metal mines
- Liming of waste water to raise the pH and precipitate metals is also practiced at several mines
- Nitrogen removal technologies have been introduced at some Swedish mines
- Removal of arsenic by ferric salt precipitation takes place at a couple of mine sites
- Overflow wetlands are a common solution at younger Finnish metal mines, efficiency in contaminant removal highly dependant on seasonal conditions
- Sulphate removal options are actively studied in Finland
- **Public data on performance characteristics of current water treatment installations not easily available!**

Output from Wascious Work Package 2

- Key contaminants for experimental work (WP3) have been decided
 - SO_4^{2-} , NO_3^- , NH_4^+ , Cu, Ni, Zn
- Reports will be available at NORDMIN website on:
 - Current status at Nordic metal mines regarding water quality, quantity and treatment
 - State-of-the-art technologies for removal of key contaminants from mine water

WASCIOUS - Dissemination

Year	Action
2014-2016	Ph D work
2014	Distribution of project flyer (NordMin web-page, FinnMin/SveMin contacts, mine water/waste conferences etc)
	Project poster
	Project presentation to NordMin steering group (Nov. 11, 2014)
	Input to Mine BAT/BREF (and/or in year 2015)
	Press release 1
2015-2016	Presentations in conferences/workshops
	Preparation of articles
2016	Press release 2
9/2016	Final report ready

Thank you for your attention!



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