Kevitsa Mine- Intro Tour

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NEW BOLIDEN

Agenda

- Boliden in Brief
- Location and Geography
- Geological Setting and Mineralization
- Mine Design and Layout
- Operations
- Recipients
- Stakeholders
- High Value nature

Our mines

AITIK
- The world's most productive open-pit copper mine
- Copper, gold and silver

BOLIDEN AREA
- Three underground mines
- Zinc, copper, lead, gold, silver and tellurium

GARPENBERG
- The world's most productive underground zinc mine
- Zinc, silver, lead, copper and gold

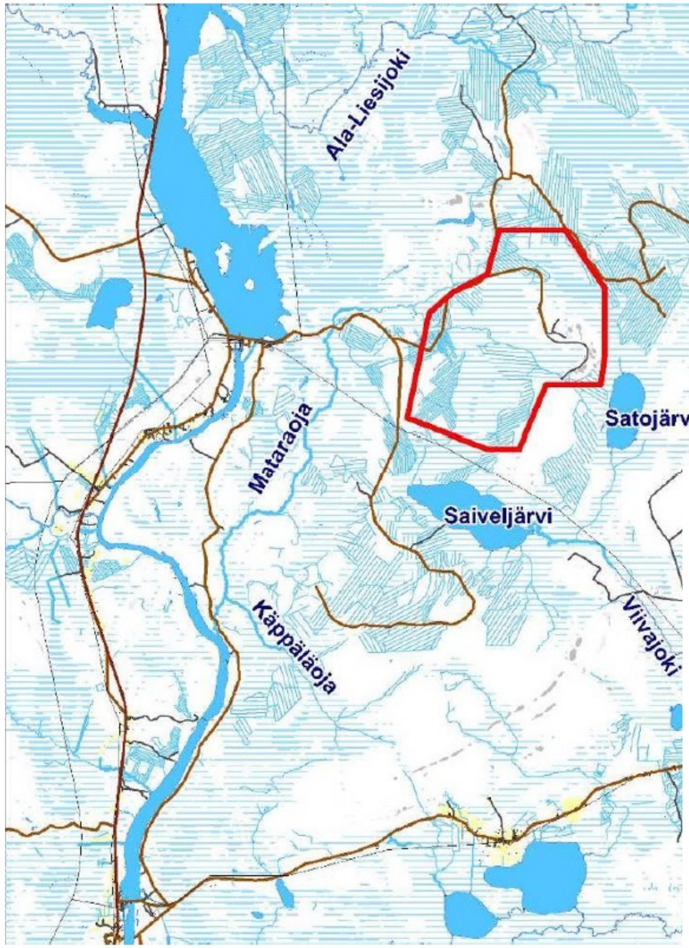
KEVITSA
- Open pit acquired in 2016
- Nickel, copper, gold, platinum, palladium and cobalt

TARA
- Europe's biggest zinc mine
- Zinc and lead

- One of Finland's largest mineral discoveries
- Nickel, copper, gold, platinum, palladium and cobalt
- Milled tonnage 2021: 9,5 Mtonnes

Geography, Climate

- Northern climate
- Bogs and peat wetlands, low hills, lakes, birch and pine forests



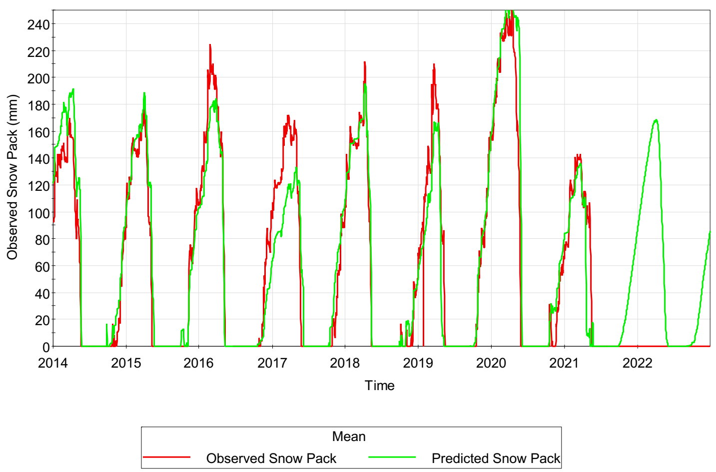


Table A: Monthly and annual climate averages for Sodankylä from 1962 to 2016

Month	Temperature (°C)		Relative Humidity (%)		Precipitation (mm)	Estimated Monthly Potential Evaporation (PE) (mm)	Snowpack Thickness (cm)	Precipitation : PE Ratio
	Max	Min	Max	Min				
January	-9.5	-19.8	89.3	81.2	26.5	0.2	50.9	<0.125
February	-8.9	-19.1	88.1	78.0	22.7	0.2	65.5	<0.125
March	-3.4	-15.0	89.5	66.0	22.8	0.9	73.6	<0.125
April	2.3	-8.1	87.6	54.1	26.2	7.9	65.5	.3
May	8.8	-0.6	85.7	48.9	36.1	54.0	16.0	1.5
June	15.7	5.5	74.1	46.2	57.0	82.7	0.0	1.5
July	18.7	8.5	87.9	51.2	69.9	91.6	0.0	1.3
August	15.8	6.2	92.2	57.4	62.8	59.0	0.0	0.9
September	9.6	1.9	94.5	66.1	54.9	26.3	0.2	0.5
October	2.1	-3.9	94.2	78.8	46.7	4.9	3.7	0.1
November	-3.9	-11.5	93.1	85.2	34.9	0.1	16.7	<0.125
December	-7.6	-17.3	90.6	82.6	27.8	0.2	34.0	<0.125
Annual	*3.3*	*-6.1*	*89.7*	*66.3*	*488.3*	*328.0*	-	*0.7*

Surfacial Geology

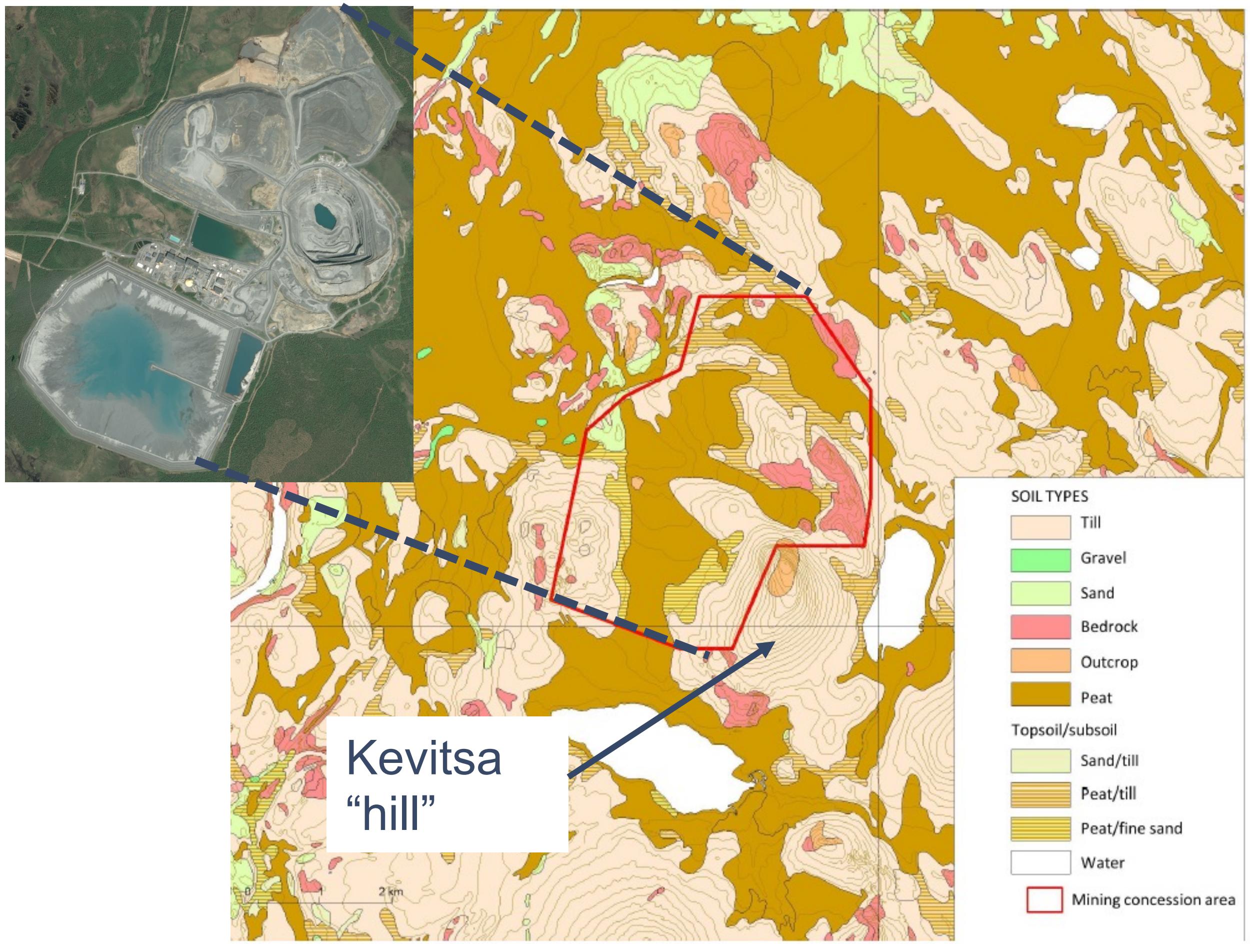


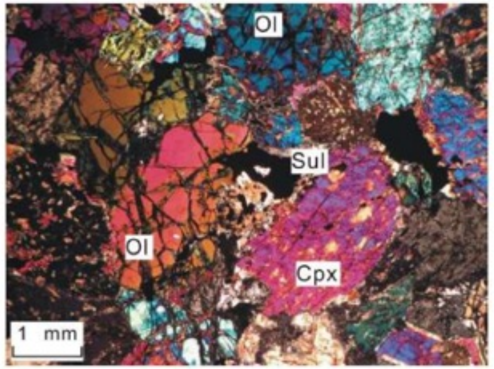
Image 9-7: Soil map of the Kevitsa area (Geological Survey of Finland, scale 1:20,000).

- Peat and till dominate the near surface.
- Peat in topographic lows (bog)
- Till on hill slopes
- Bedrock at surface as subcrop or rubble crop features.

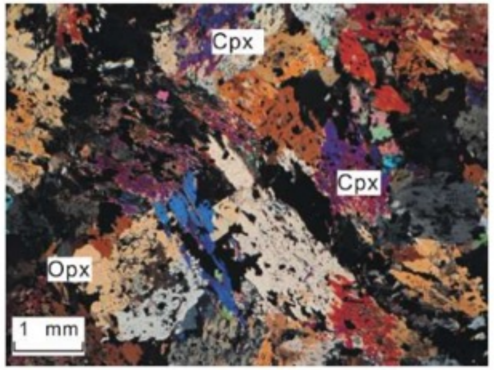
Kevitsa igneous ultramafic complex

- Local geological context

  - Host ultramafic rocks – Differentiated magmatic pulses with compositions varying mostly from **olivine websterite** and **olivine clinopyroxenite** with lesser amounts of wehrlite, lherzolite, and clinopyroxenite

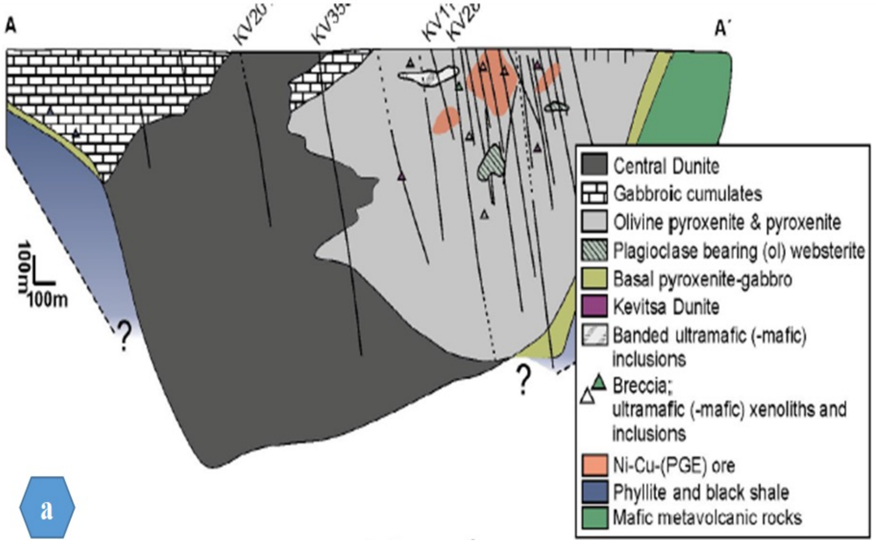


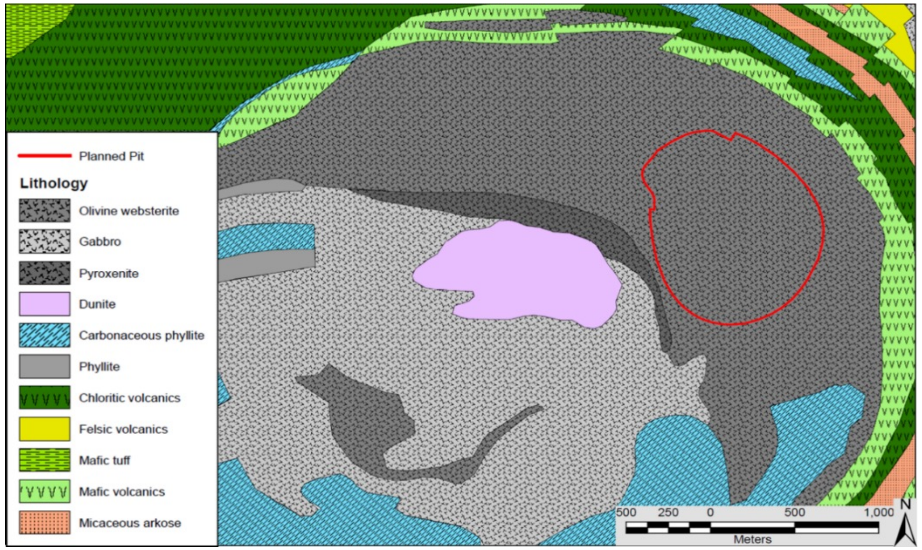
Olivine Clinopyroxenite



Olivine Websterite

  - Sedimentary and dunitic xenoliths as inclusions in main ultramafic mass



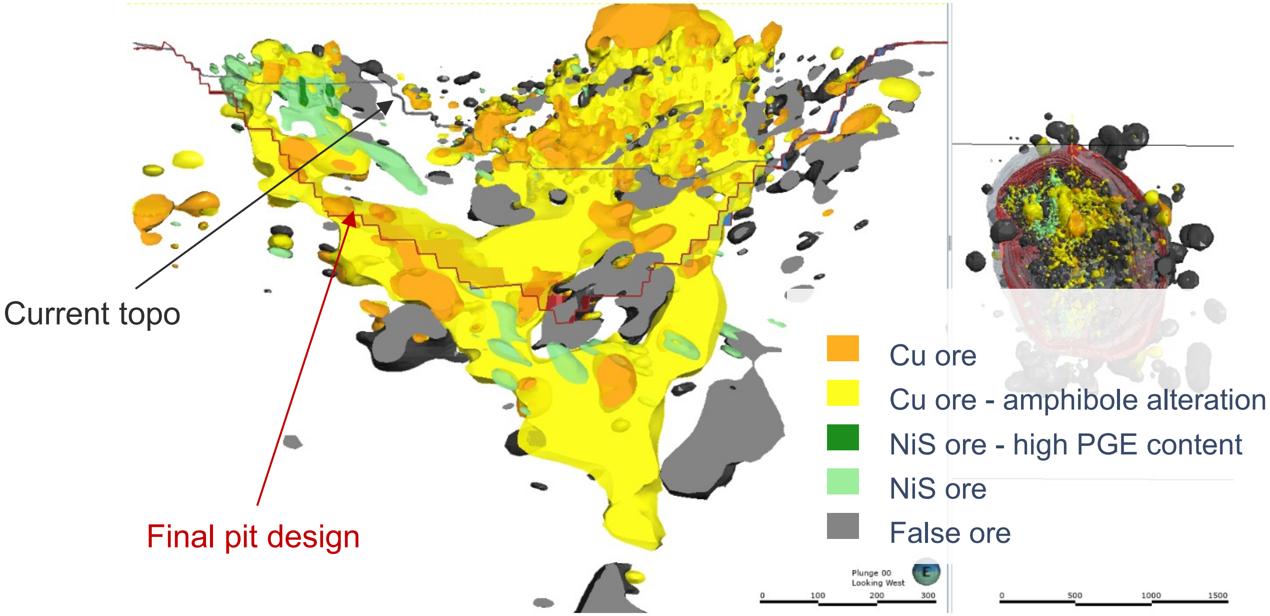


Kevitsa mineralisation

- Regular or Normal Ore: Cu ore
  - Main mass of Kevitsa deposit
  - Typical sulphide mineral paragenesis: pentlandite, chalcopyrite and pyrrhotite
  - Variable amphibole alteration intensity

- NiS ore
  - High Ni/Cu
  - Typical sulphide mineral paragenesis: pentlandite, millerite and pyrite
  - Variable Au and PGE content

- False Ore: non economical ore
  - High S content but uneconomical



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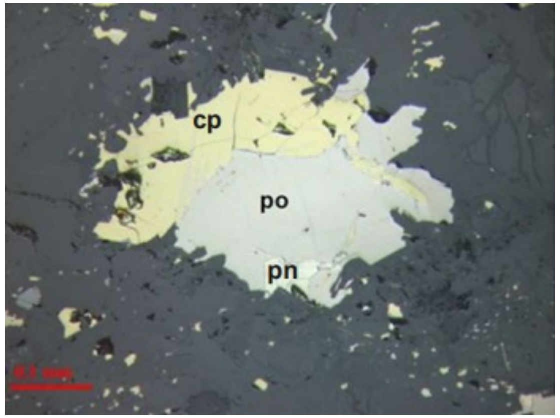
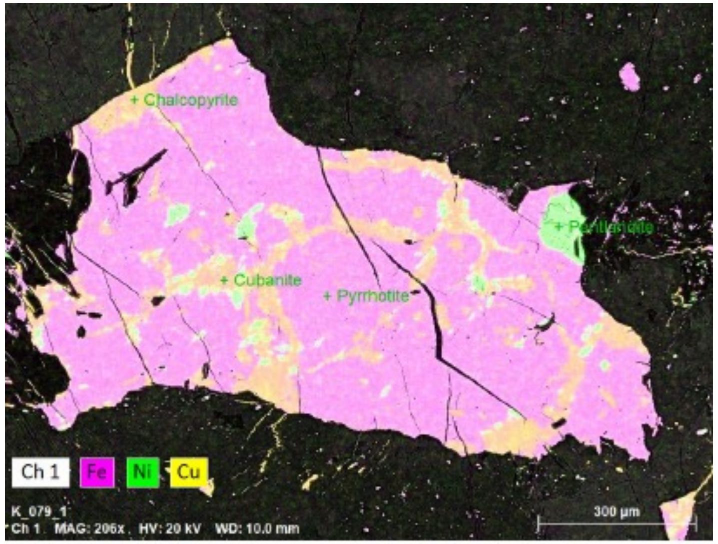
Kevitsa alteration

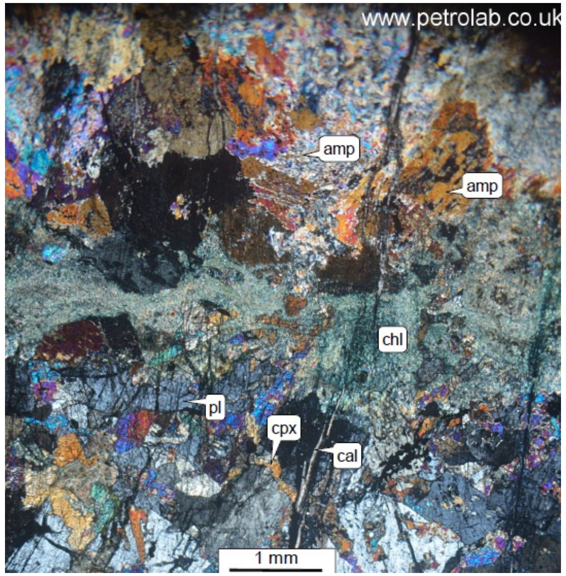
- Alteration
  - various origins (pervasive, fracture controlled, veins selvage, foliation developed)
  - and intensity degrees (minor to intense)
- Amphibole alteration
  - Primary textures destroyed when intense alteration
  - Pyrrhotite is replaced by magnetite
- Serpentine alteration replaces olivine
- Other secondary minerals are actinolite, chlorite, epidote, and hematite
- Carbonate alteration typically occurs as veins and fracture filling

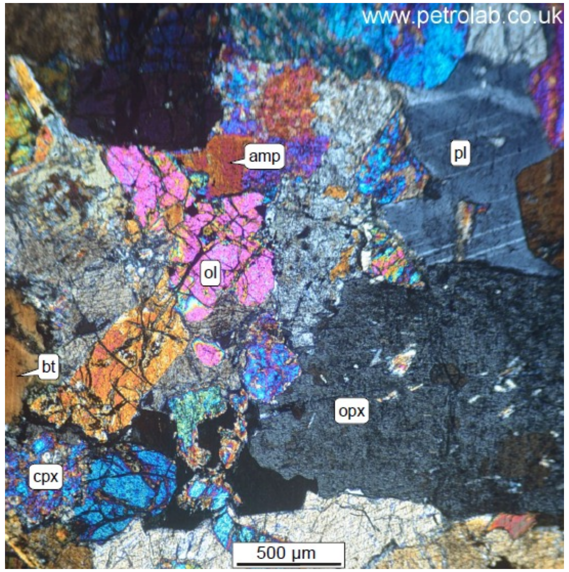


Fine grains of sulphides occur as a halo around larger grains as a result of intense amphibole alteration representing minor remobilization

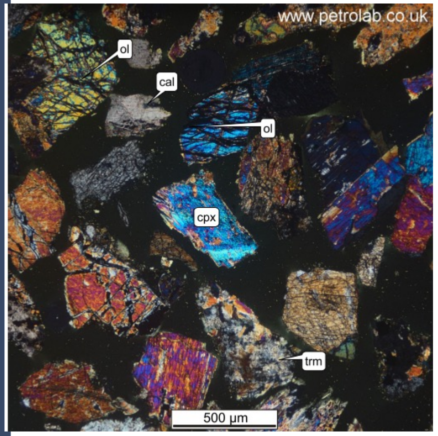
[Wt.%]	Waste Rock Sample
Pyrrhotite	0.6
Calcite	0.2
Dolomite	0.1
Pyrite	0.2
Clinopyroxene	63.2
Orthopyroxene	17.3
Amphibole	10.7
Serpentine	1.6
Anorthite	1.1
Magnetite	1.6
Goethite	1.2
Chrome-magnetite	0.3
Albite	0.1
Biotite	0.5
Chalcopyrite	0.1
Quartz	0.1
Phlogopite	0.1
Accessory Phases	0.1
Hematite	0.2
Ilmenite	0.1
Galena	0.0
Olivine	0.2
Chlorite	0.1
Pentlandite	0.1
Kaolinite_Illite	0.0
Ankerite	0.0
Muscovite	0.0
Sphalerite	0.0
Titanomagnetite	0.0
Sulfates	0.0
Arsenopyrite	0.0
Baryte	0.0

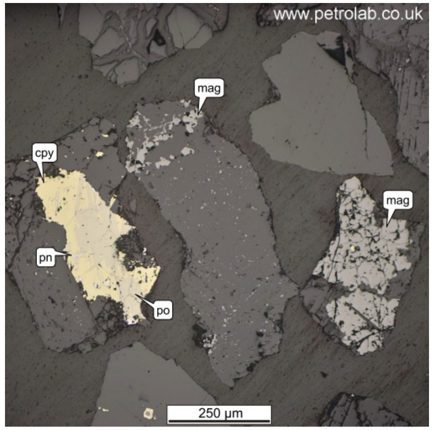


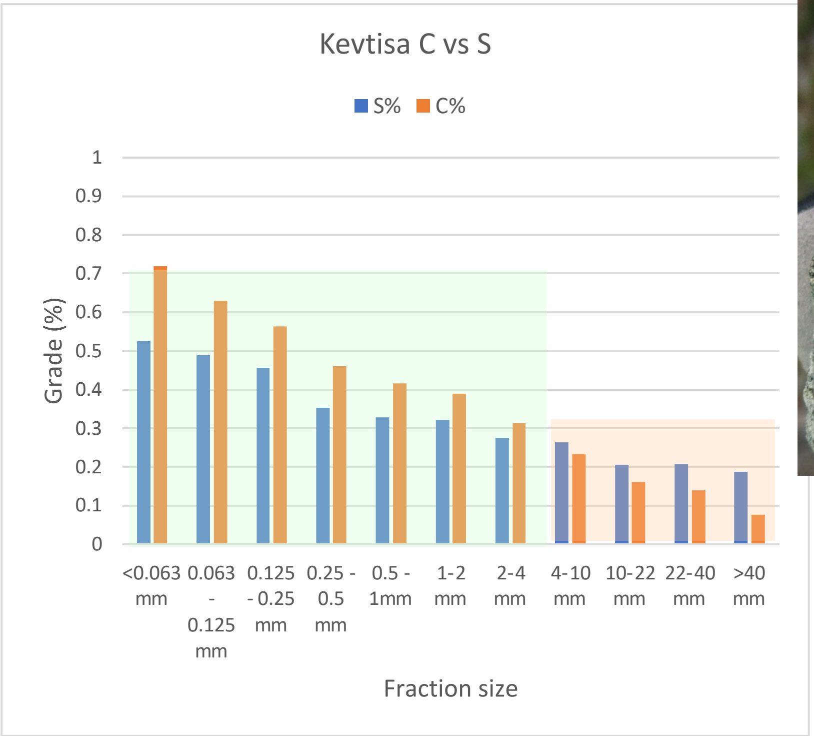


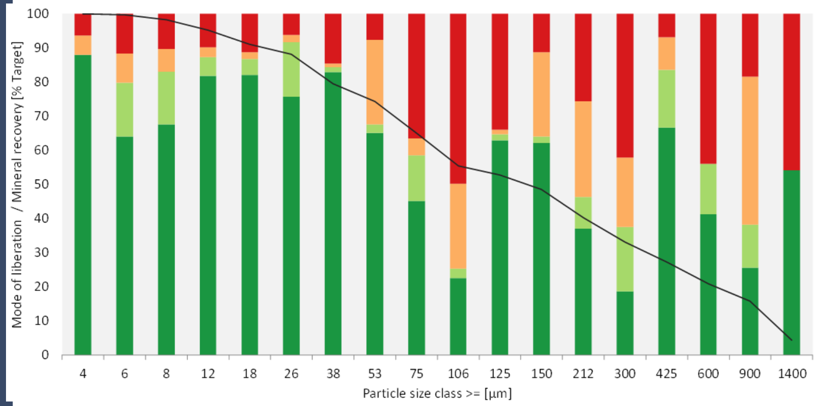


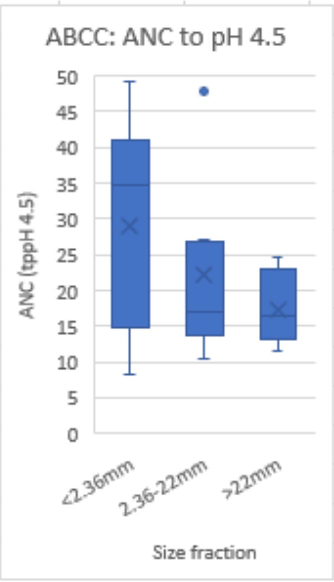
Fragmentation effects based on mineralogy







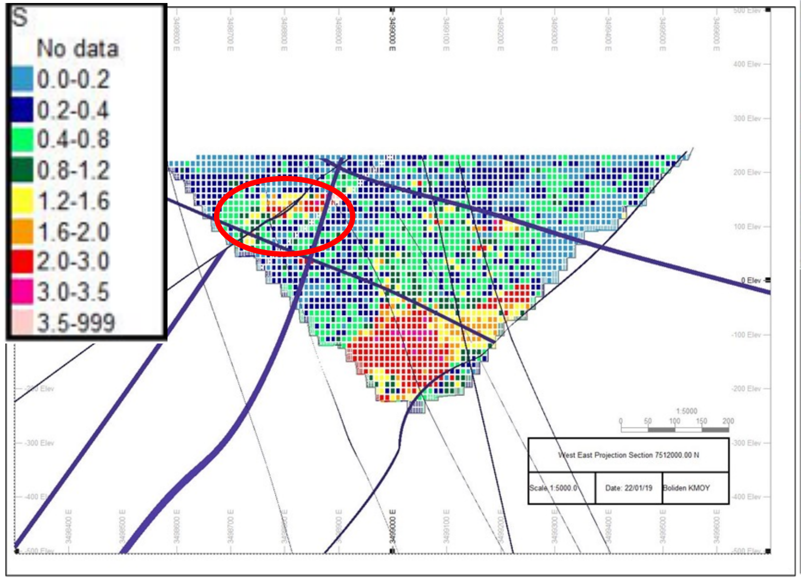


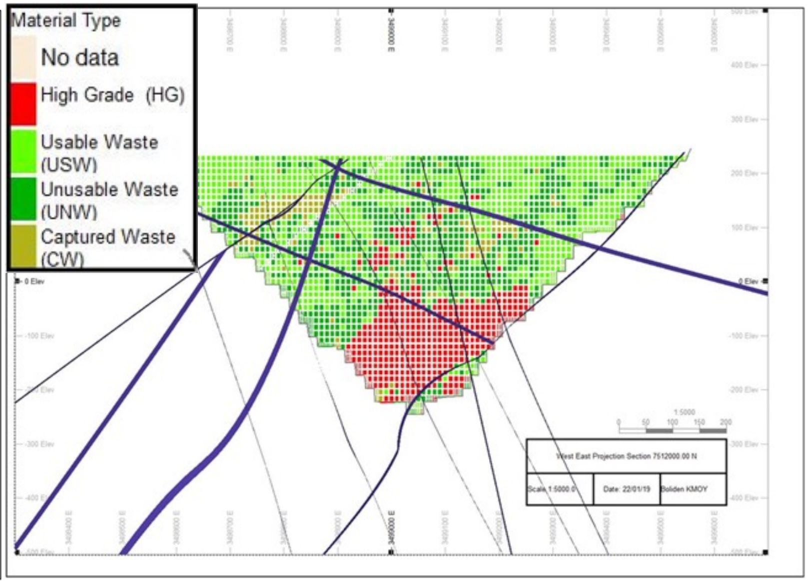


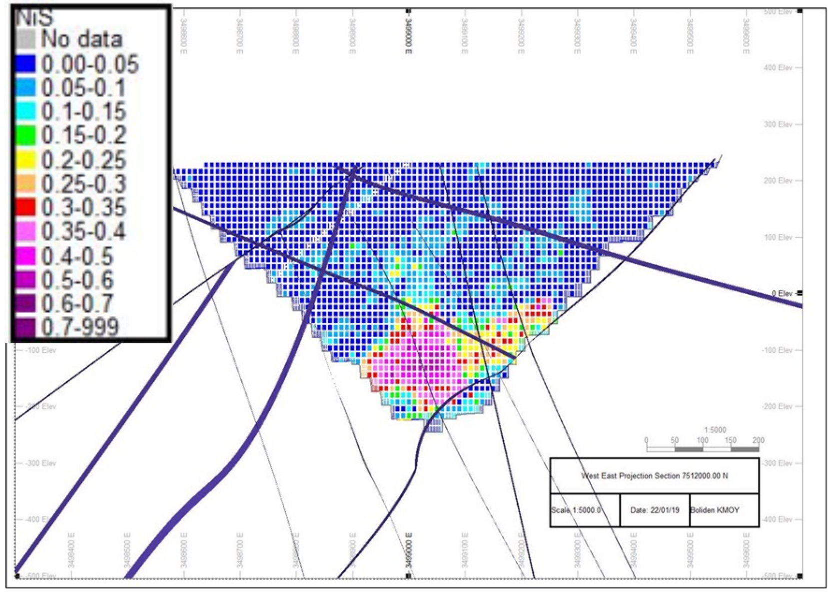
- Carbonates are concentrated and well liberated at the finer grain sizes (<2mm) indicating that available carbonate buffering is high and material is likely to support circum neutral drainage conditions as acid neutralisation can keep up with acid production rates. This is seen in kinetic testing data to date.

Ore and waste control

- Ore vs waste definition is based on Net Smelter Return (NSR) in €
- Kevitsa NSR is function of economical grades (NiS, Cu, CoS, Au, Pt and Pd)
- Penalizing minerals such as talc or amphibole are also taken into account in the forecasted feed to the mill
- Ore control as opposed to grade control: geo-metallurgy central decision making

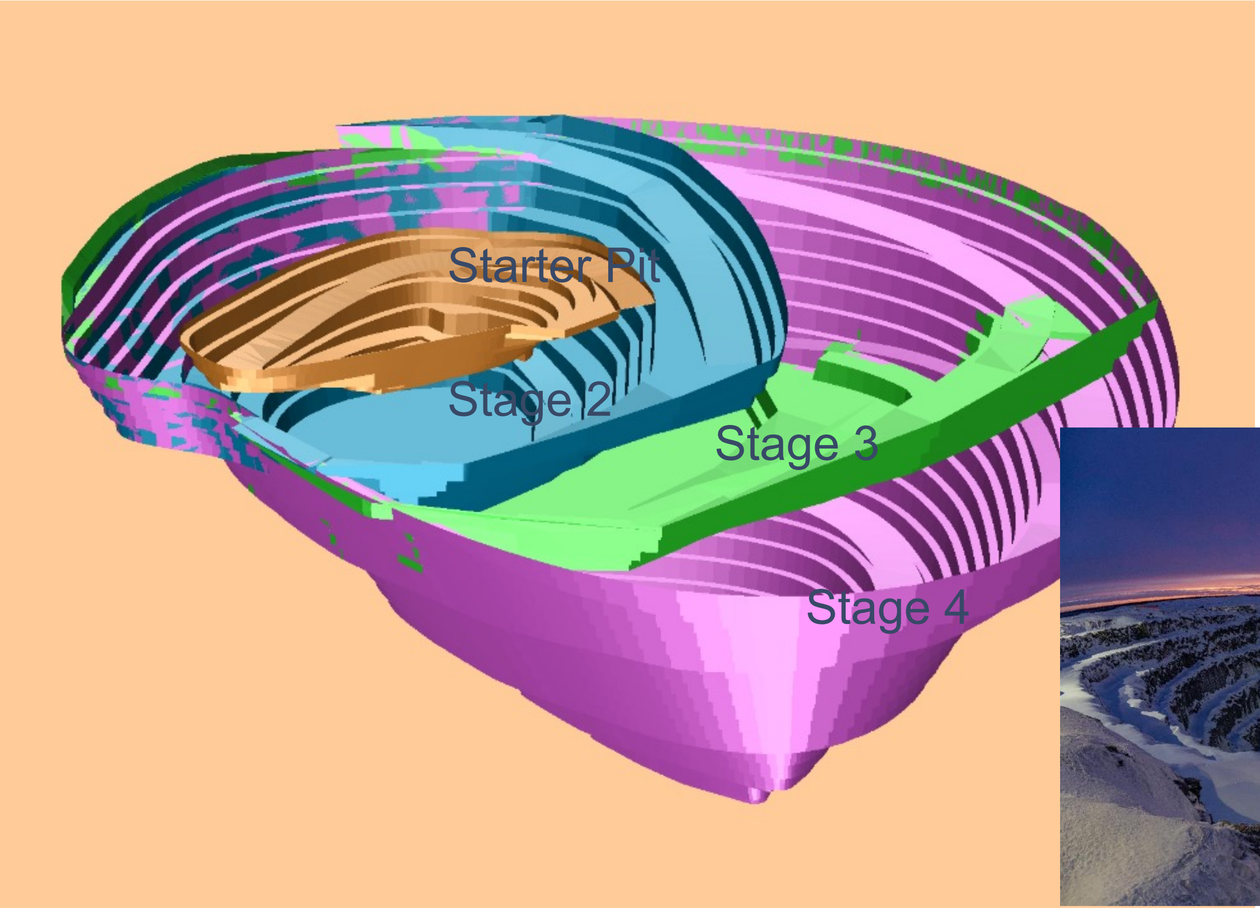




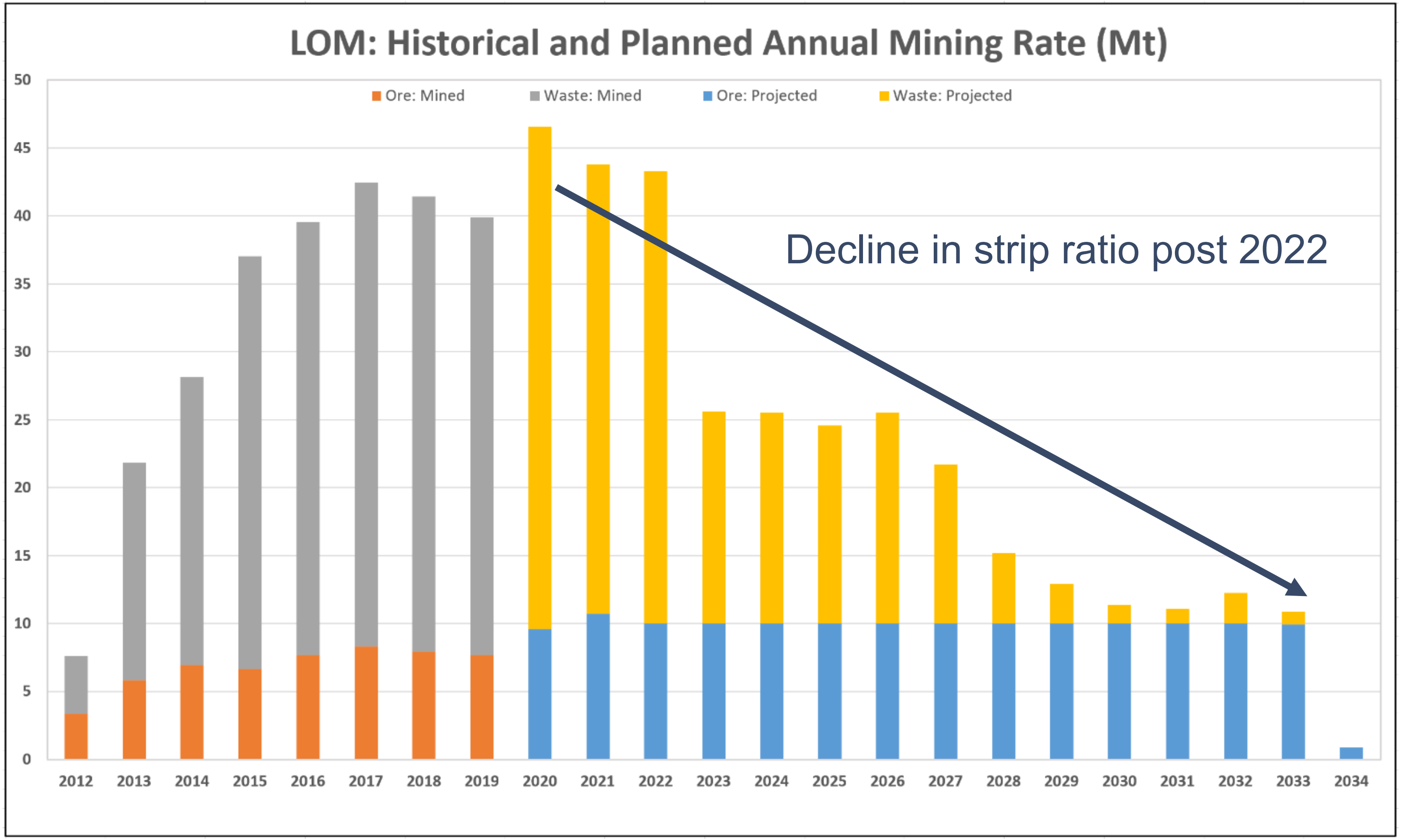


Mining Schedule : Stages 1 - 4

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Starter Pit																							
Stage 2																							
Stage 3																							
Stage 4																							



January 11th, 2020


LOM: Historical and Planned Annual Mining Rate (Mt)
Ore: Mined
Waste: Mined
Ore: Projected
Waste: Projected
0
5
10
15
20
25
30
35
40
45
50
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
Decline in strip ratio post 2022

Minining Fleet: Loaders+Hauling

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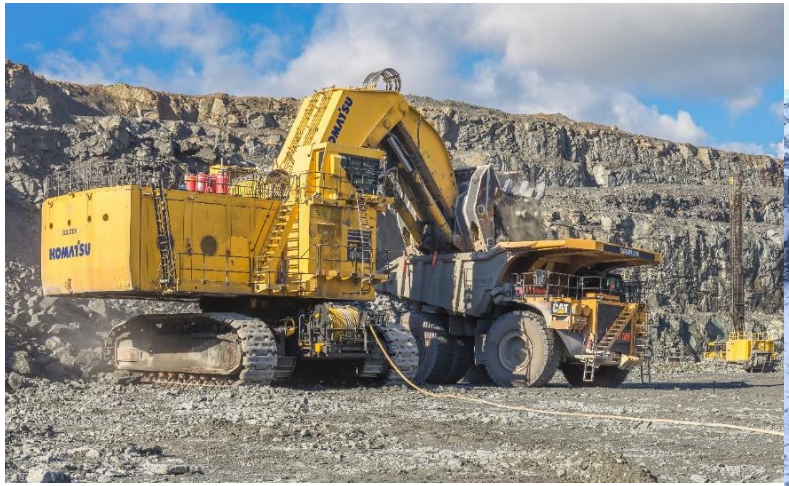


KOMATSU PC8000: Shovel

- Bucket volume 36 m^3
- 1 unit
- **Electric** / hydraulic
- Weight 720 t
- Power 2 x 1 450 kW, voltage 6.3 kV
- Track width 8.15 m, cabin height 9.5 m

KOMATSU PC5500, CAT 6060, KOMATSU WA1200

KOMATSU 830E: Truck

- Payload capacity 227 t (110 m^3)
- 17 units in 2020
- Diesel - **electric** 2500 hp
- Empty weight 182 t
- Track 7.0 m, height 7.15 m, length 14.65 m

Electrification of fleet

- PC8000 Europe's largest electric loader

Ore & waste control: Drilling & Sampling

- DD drilling
  - Logging & sampling
  - Assay & XRD data
  - Geotechnical information
  - → Resource estimation

- RC drilling
  - Sampling
  - Assay & XRD data
  - Tighter drill grid to increase resolution along ore/waste contacts and characteristics of material
  - → Grade Control estimation

Production drilling:

Epiroc Pit Viper 271 <u>Electric</u>, 4 rigs

- Down-the-hole, hole diameter 225 mm
- Boom height 20 m
- Weight 95 t
- Electric, 6.3 kV

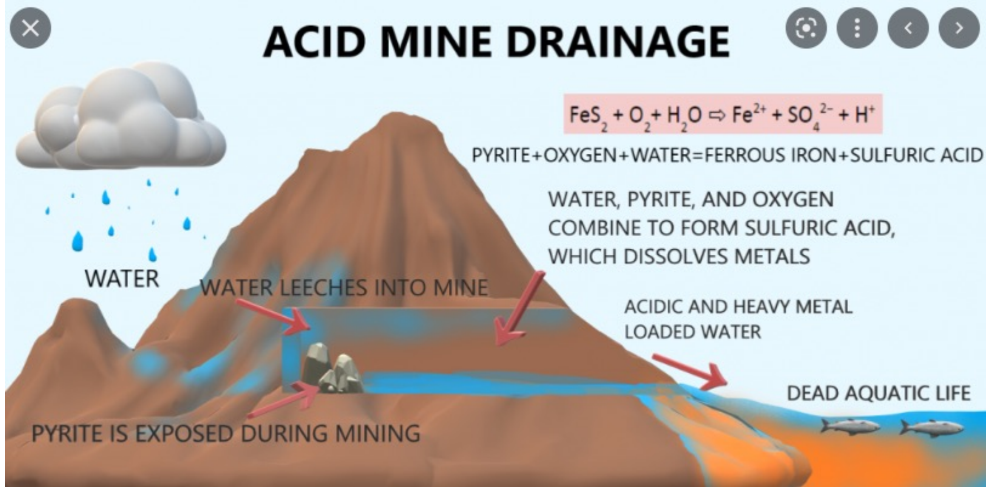
Epiroc D65 smartROC Drill, 6 rigs

- •M6 DTH-hammer
- •Hole diameter 165mm

Waste control

- Waste categories are defined depening on potential impact on the environement
- Priority: avoid Acid Mine Drainage
- Usable waste: low S and low NiS content
- Depending on S content waste is considered as ”unusable” or ”captured”

Material type	Abbreviation	MAT_TYPE Column value	Category definition
High Grade	HG	26	NSR15>=15
Usable Waste	USW	28	NSR15<15, Sulphur % <0.3 and NiS % <0.1
Unusable Waste	UNW	29	NSR15<15 Sulphur % 0.3 to 0.8
Capsulated waste	CW	30	NSR15<15 Sulphur % >=0.8

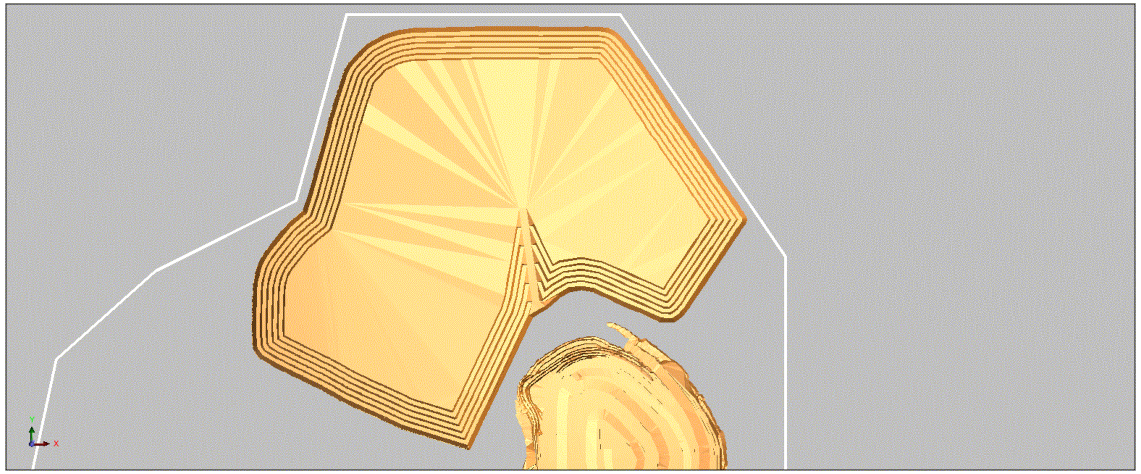


Waste type	Sulfur grade (%)	Ni (mg/kg)	NiS (mg/kg)	Cu (mg/kg)	CuS (mg/kg)	Co (mg/kg)	CoS (mg/kg)	Carbonates (Ccarb)%
USW	0.17	600	300	300	280	60	30	0.17
UNW	0.5	800	500	600	550	75	45	0.23
CW	1.3	800	600	850	800	120	60	0.2
HG	1.5	2,400	2,150	3,100	3,000	110	100	0.1

Current Waste Rock Storage Facility

Z = 285

Remaining volume: 141,543,000 m^3= 341,881,000 tonnes
Surface Area at 220: 3,700,000 m^2



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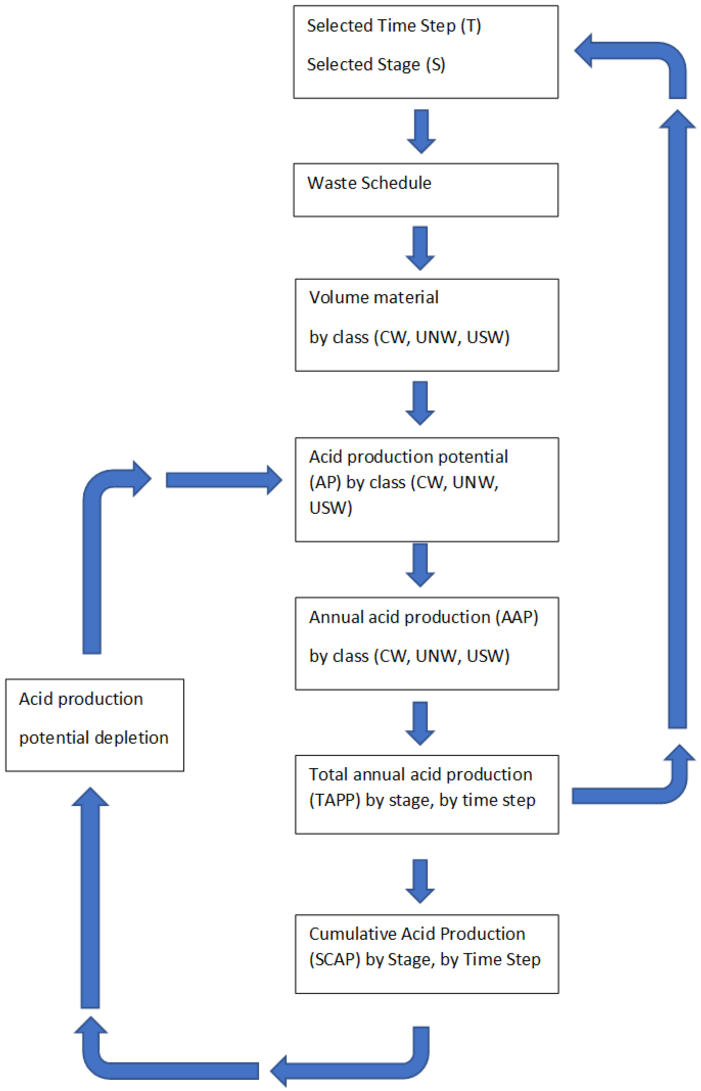
WRD model

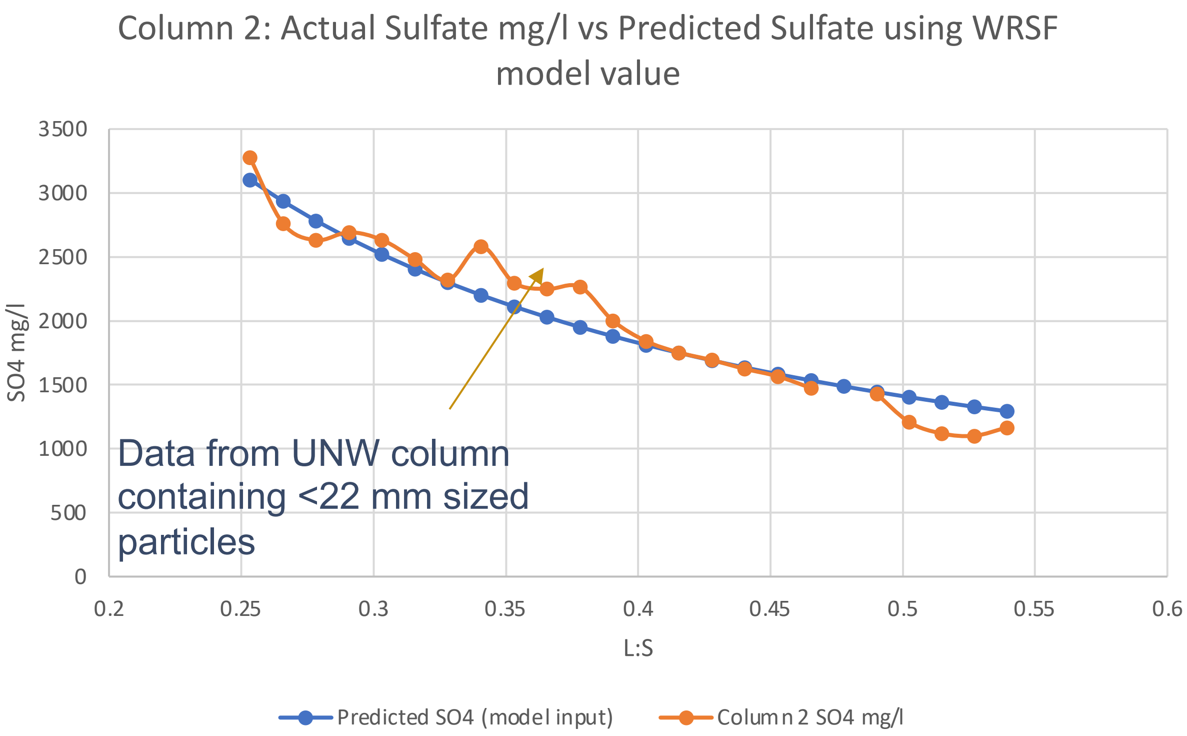
- Model based on:
  - Waste schedule timing and volumes of waste
  - Grades based on adjusted block model parameters
  - Oxidation rates based on adjusted IOR (PSD and temperature)
  - Buffering rate based on PSD adjusted buffering potential
  - Sulfate release based on upflow column testing
  - Metal release based on ratio to sulfur and pH (pH based solubility function based on sequential leach testing)
  - Cover performance based on OKC model outputs

Unique mineralogy reduces risk of ARDML

- Model prediction that carbonate buffering will be sufficient to maintain pH>7.5 which will reduce nickel mobility as a result of sorption to iron hydroxides
- Circum neutral pH means precipitation of gypsum will result in solubility constraint on secondary sulfate dissolution
- Mineral carbonation proved in testing indicating material will generate carbonates as a result of silicate weathering



Kinetic testing columns program used to validate predictive model



Material	Column	pH	Ni/S ratio	Model values
Waste rock	USW	8.4	0.0004	0.0004
	UNW fines	8.2	0.002	0.002
	CW	7.6	0.002	0.002

Strong correlation between modelled data and column data indicates that the solubility-constraint-factor approach used for modelling is appropriate.

Ni/S ratios from the columns match the values used for modelling Ni release rates, validating this approach

The empirical results mean there is a high degree of confidence in the model output.

Kevitsa Concentrator

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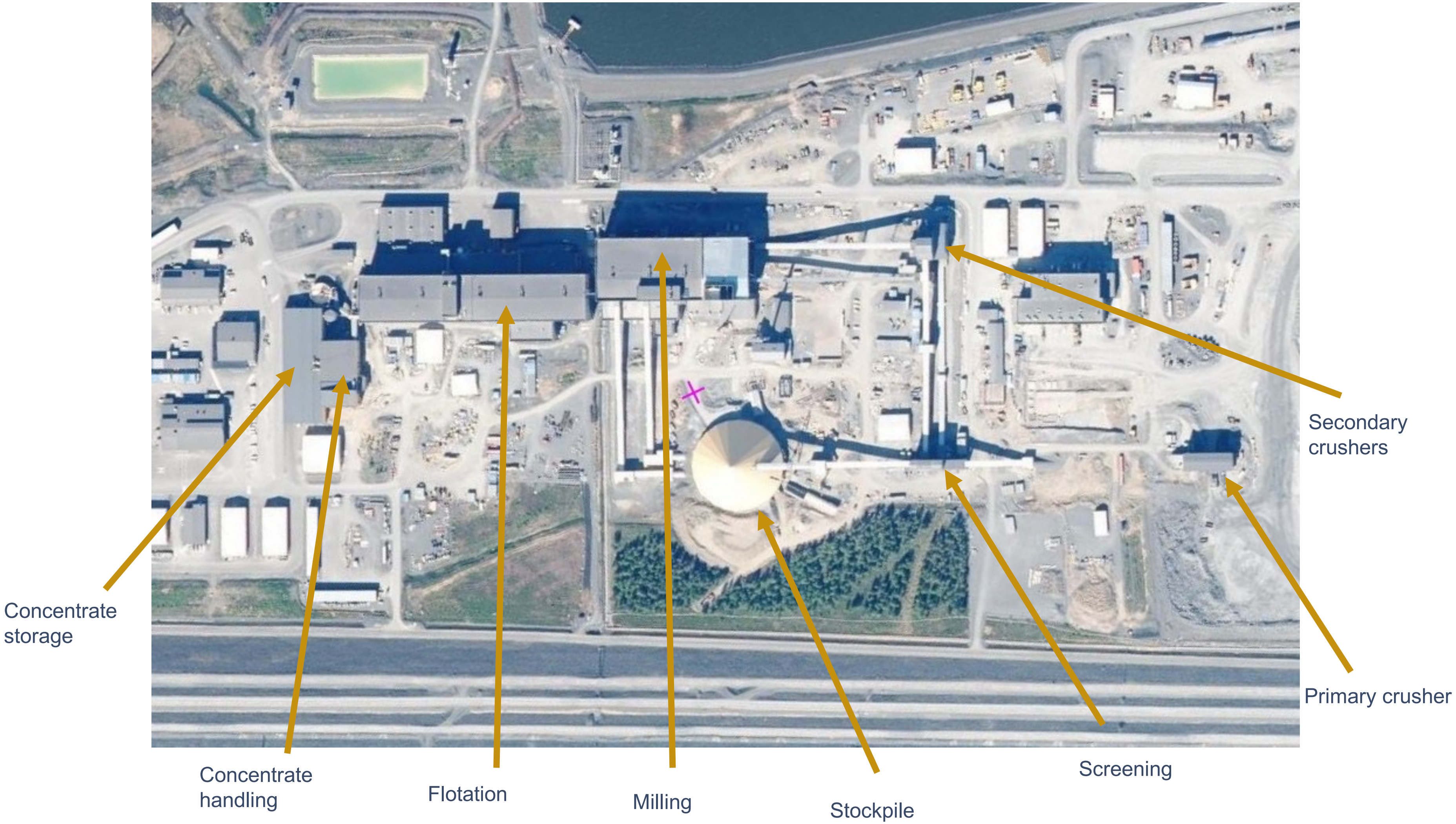


Tailings Deposition and Water Treatment

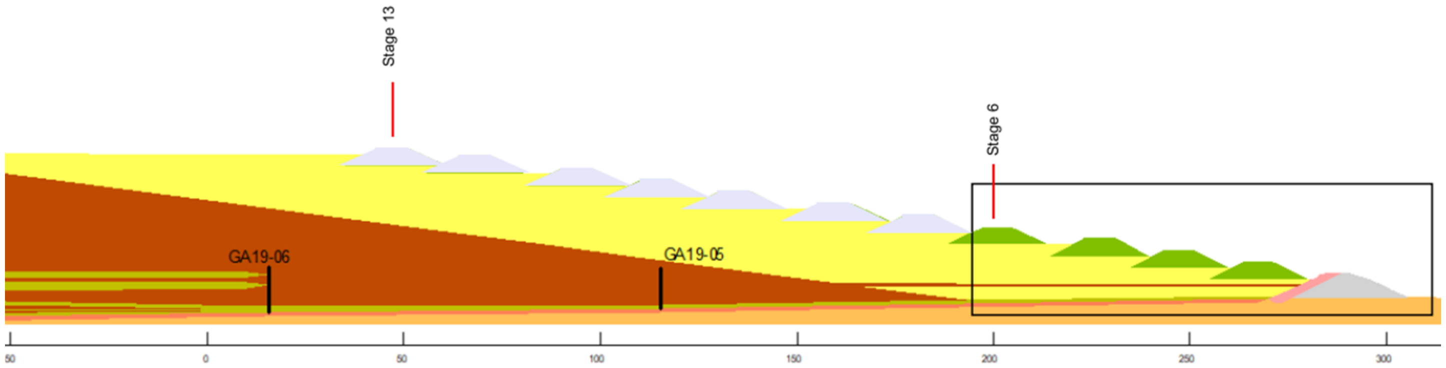
Two different ponds

Pond A for low sulphur tails

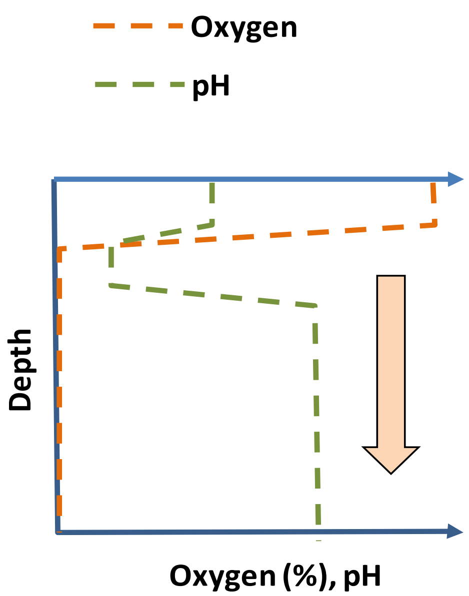
Pond B for high sulphur tails

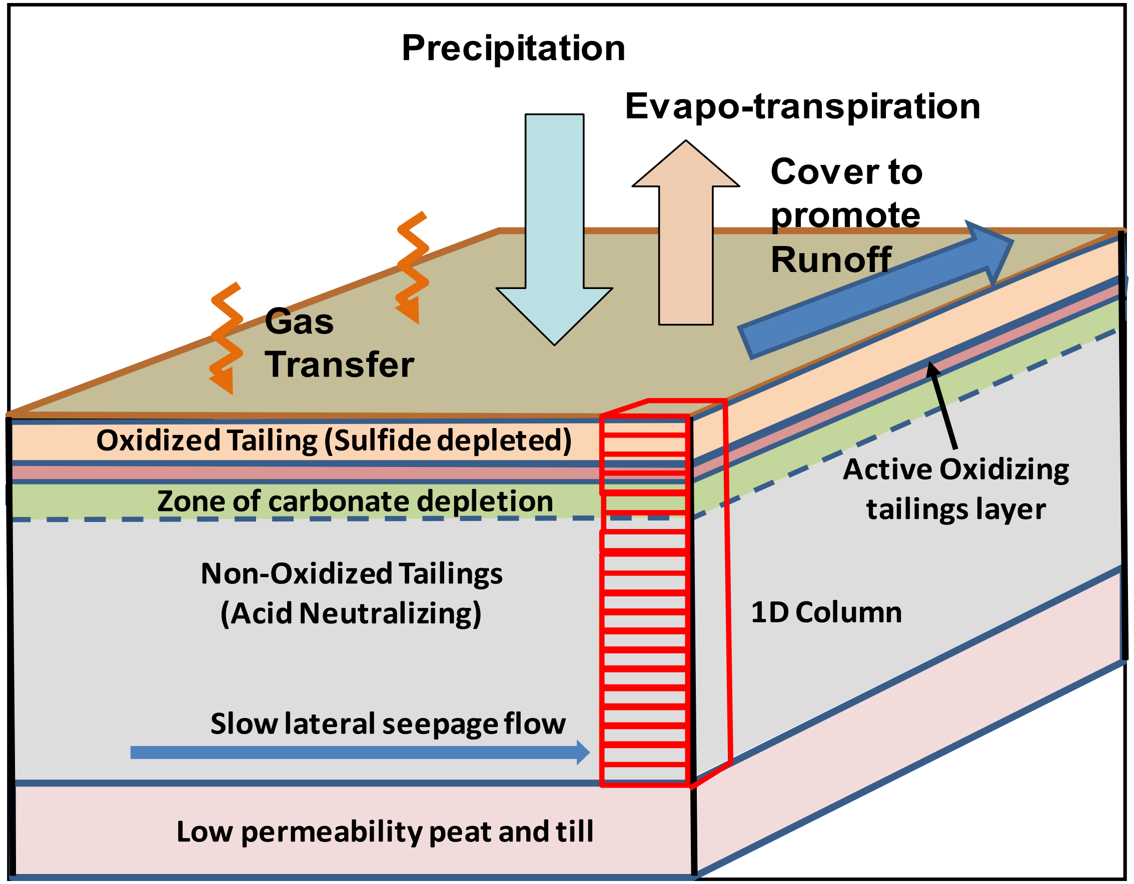
Process water is cleaned in water treatment before returning it to Vajukoski

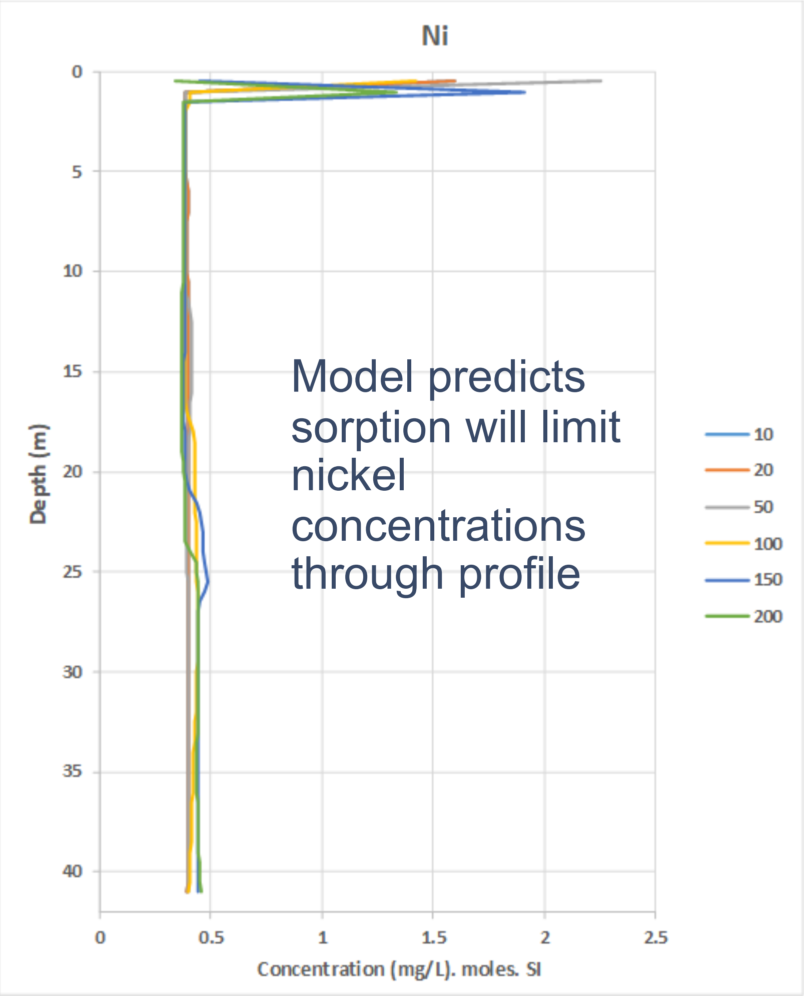
Up to 95% of used process water is circulated



Modelling carried out on tailings







Unique mineralogy of tailings reduces nickel release potential, pH maintained >8 due to carbonate and silicate buffering which results in higher levels of sorption to iron hydroxides

Investigating controls on nickel mobility

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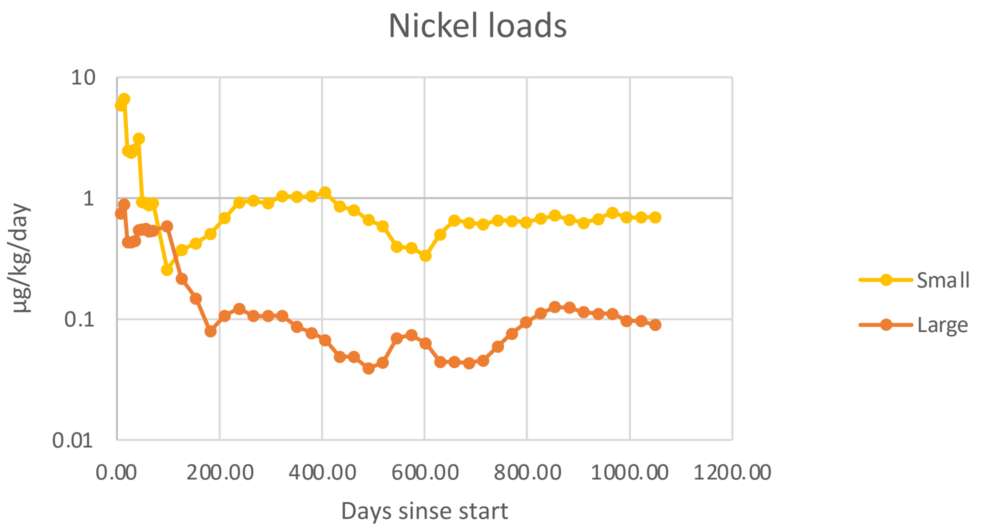
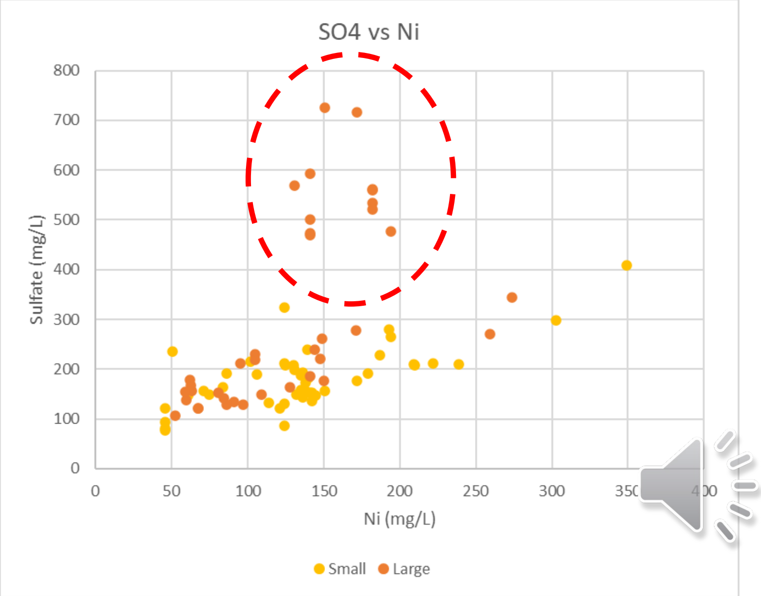
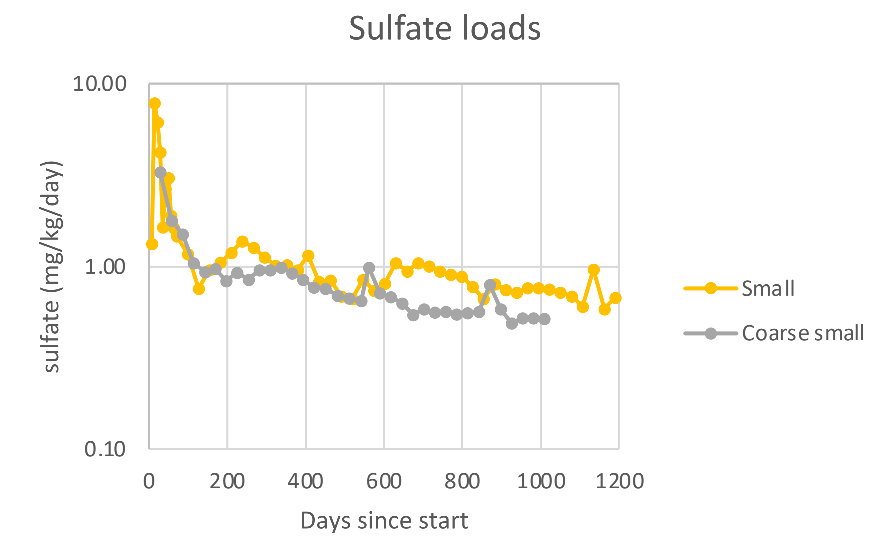
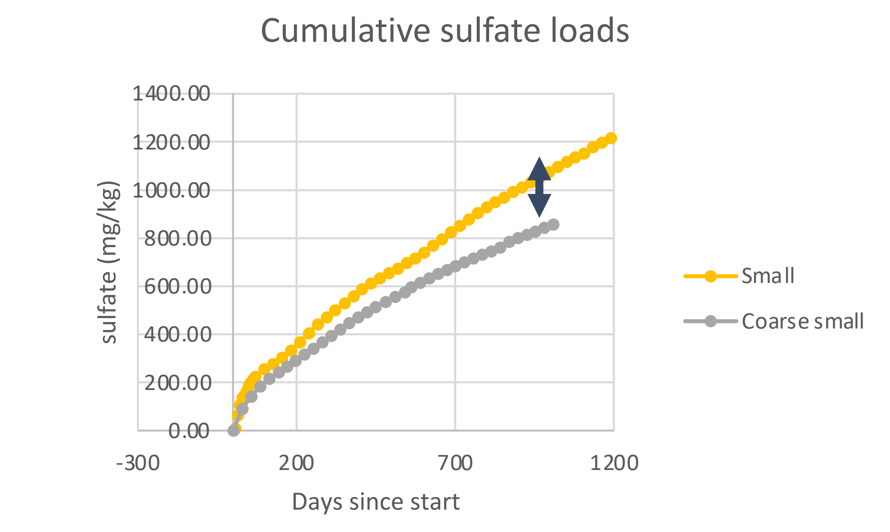




- Unique mineralogy of tailings reduces nickel release potential
- Based on nickel to sulfate ratios it is interpreted that increased sorption is occurring in the large column which is reducing nickel concentration relative to sulfate resulting in lower nickel loads
- Results agree with model
  - concentrations of nickel in column seepage <300ug/l compared to model which predicts ~400 ug/l
  - Concentrations higher in small column compared to model which predicts concentrations higher at shallow depth

Investigating difference between beach and pond tailings

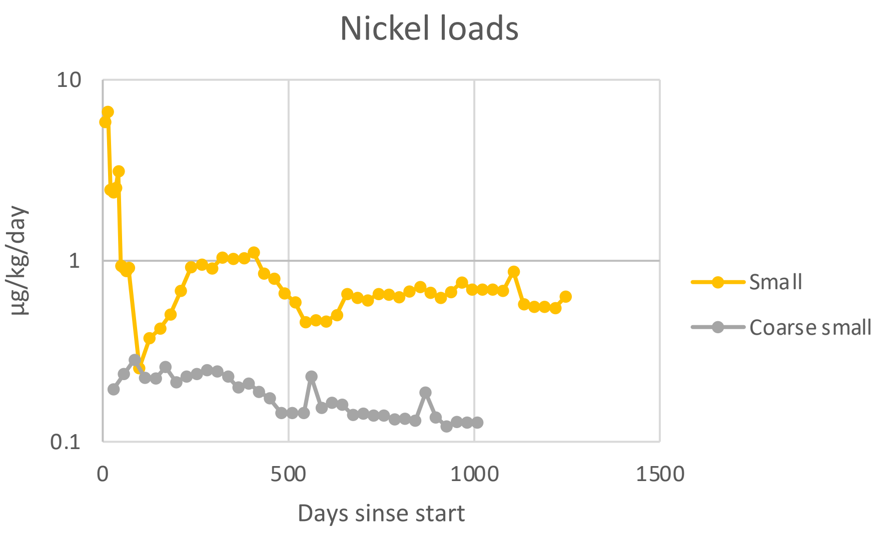


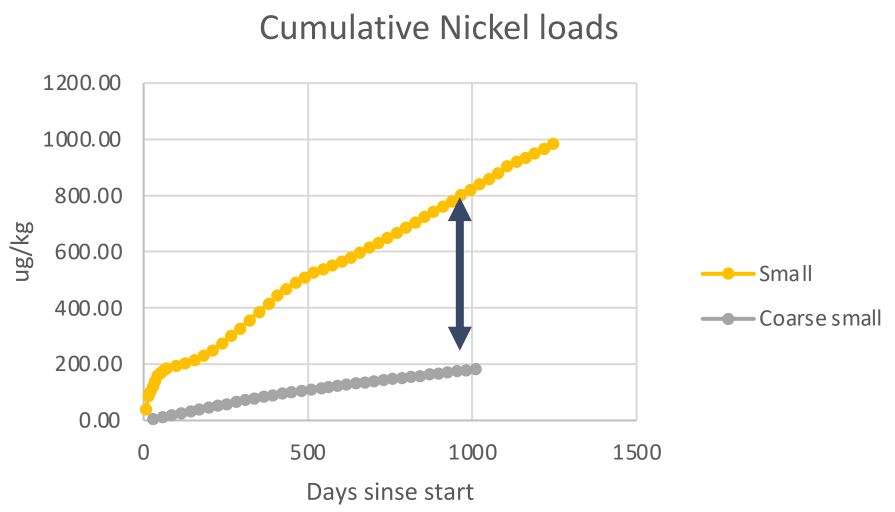


Comparable suflate release rates per day from mixed and coarse tailings

Ni release is higher from the mixed compared to coarse tailings

Over the first 1000 days of testing this reflects 20% lower sulfate load released from the coarse tailings, but 75% lower Ni load released relative to mixed tailings





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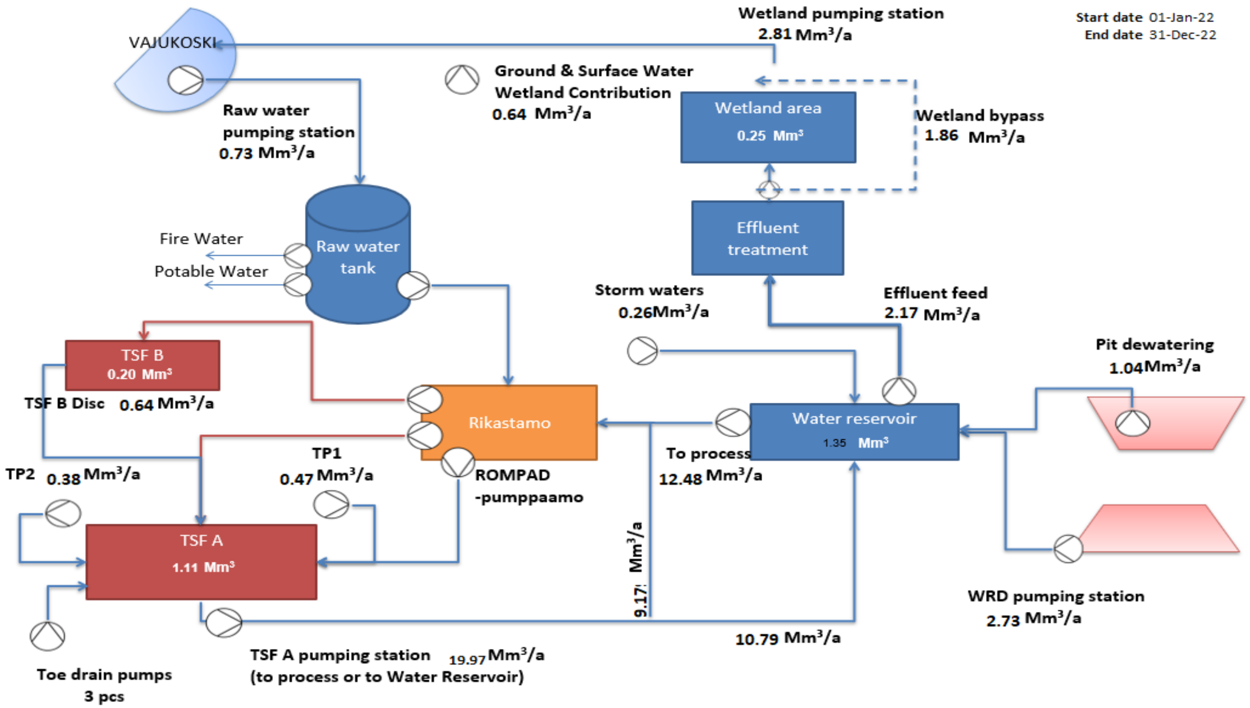
Water Management

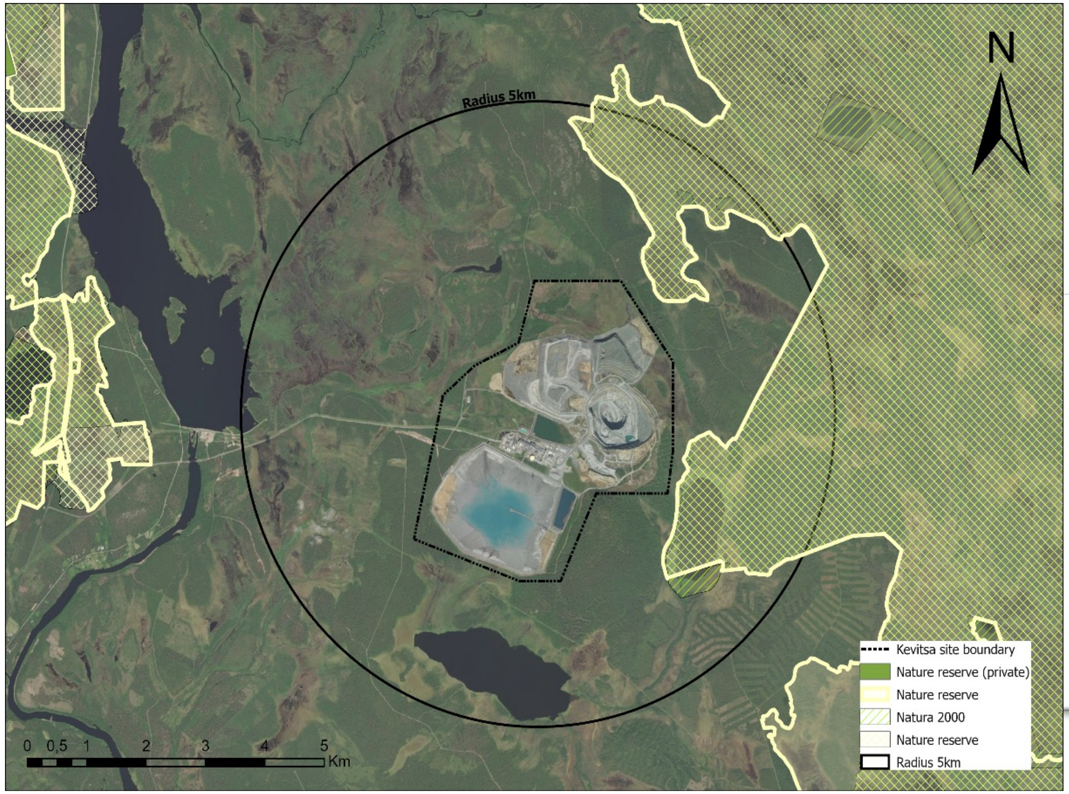


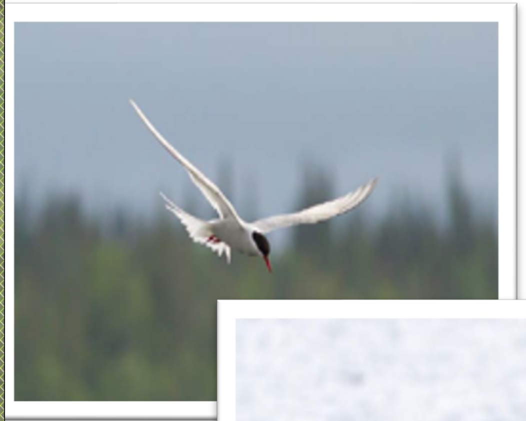
GoldSim Water Balance Prediction for 2022.

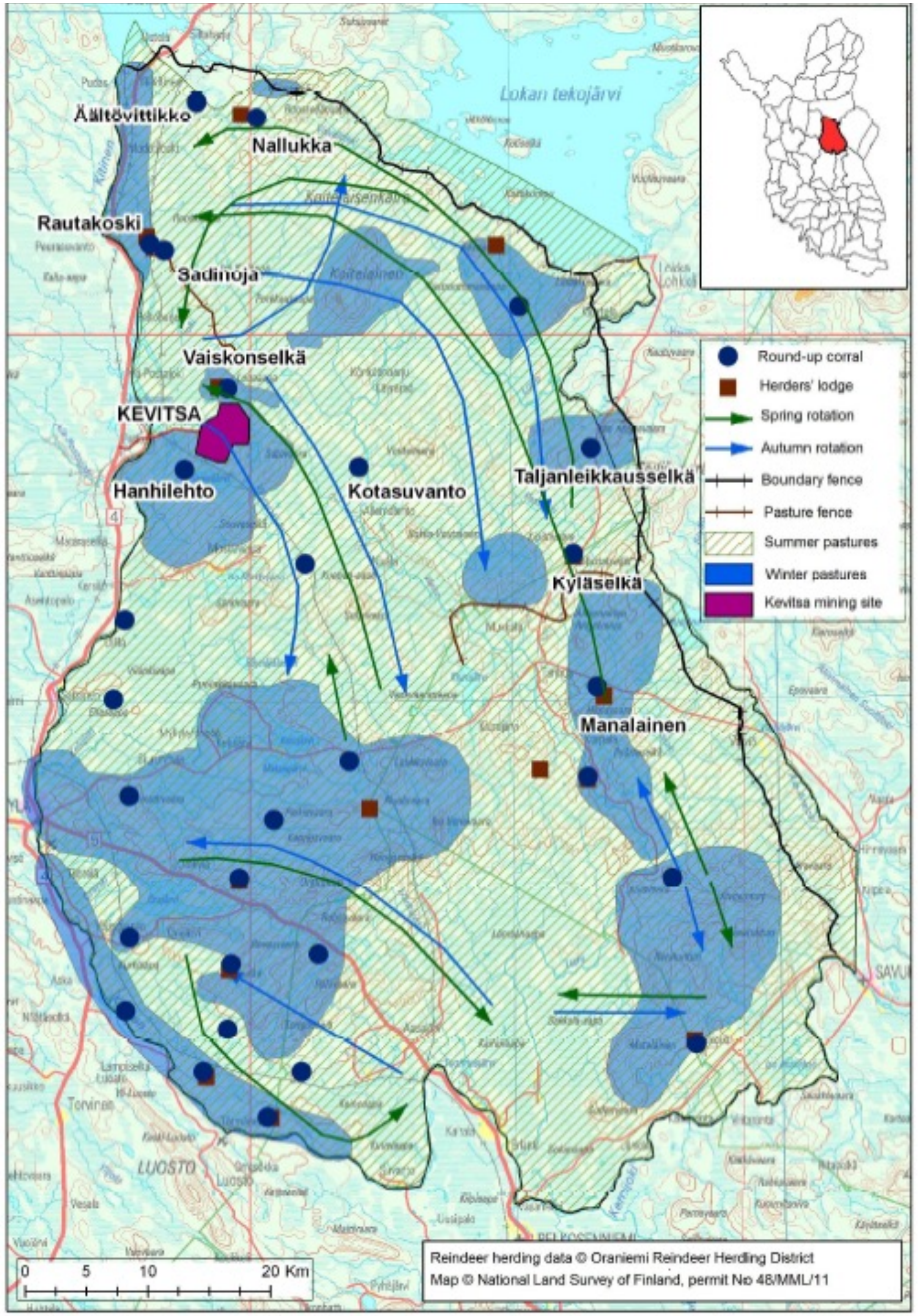
Water Management ”Principles”

- TSF A is the main water storage pond
- Process water pond is acting as the balancing volume and recipient for mine waters.
- Either water source, or pond, have sufficient capacity to supply the operation with the needed process water alone.
- Process water pond receive various water streams (e.g. Mine de-watering, storomwater pond, waste rock area seepage water) and feeds the process water treatment plants.
- All water released from site goes through water treatment, either METP or ETP plant.
- The wetland is, by the permit, only in use from 1.June till 30. September. Wetland is mainly fed from the efluent treatment plant (ETP).
- Water discharged to the Vajukoski Reservior portion of the Kittinen River.

N2000 and Wildlife







NEW BOLIDEN

- Kevitsa Mine lies within traditional lands of the Sami peoples
- The mining area is within traditional reindeer herding and grazing areas

THANK YOU - KIITOS

CONCENTRATE PRODUCTS

NEW BOLIDEN

Cu shipped in bulk

To port of Kemi

Final destinations
Finland
Sweden

Ni shipped in bulk

To port of Kemi

From Kemi to Harjavalta via rail or vessels

Kevitsa Project History

Kevitsa Project History	
1960s	Mapping of outcrops and river boulders
1970s	Outokumpu reconnaissance exploration work
1984	Initial diamond drilling (GTK)
1984-1987	Ground geophysical surveys (magnetic, gravity, electromagnetic) and basal till sampling
1987	Diamond drilling and discovery of Ni-Cu mineralization
1990	Diamond drilling
1992-1995	Main diamond drilling and trenching programme
1994	Airborne Survey GTK
1996-1998	Till geochemistry and drilling and processing test work undertaken by Outokumpu Metals & Resources
2000	Project owned by SGL
2008	Project owned by FQM
2010	Construction commenced
2012	Commercial production
2016	FQM sells the Kevitsa Mine to Boliden Mineral AB
2020	Commissioning of 9.5 Mtpa expansion project, with design capacity of 9.9 Mtpa