Recovery of metals from a seepage water of a mine (AMD)

Joined workshop of EIT RM Morecovery project

27 September 2019

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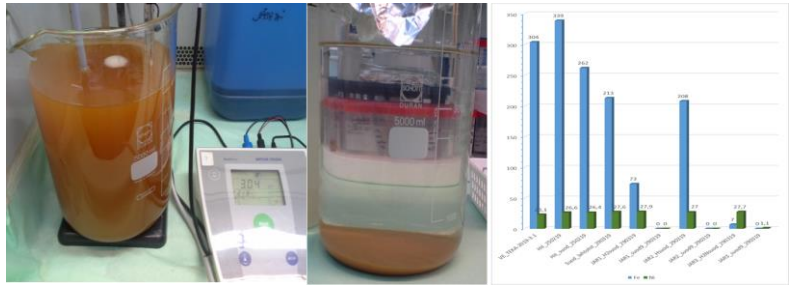
University of Eastern Finland



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Mine drainage types

Acid Rock Drainage/Acid Mine Drainage (ARD/AMD):

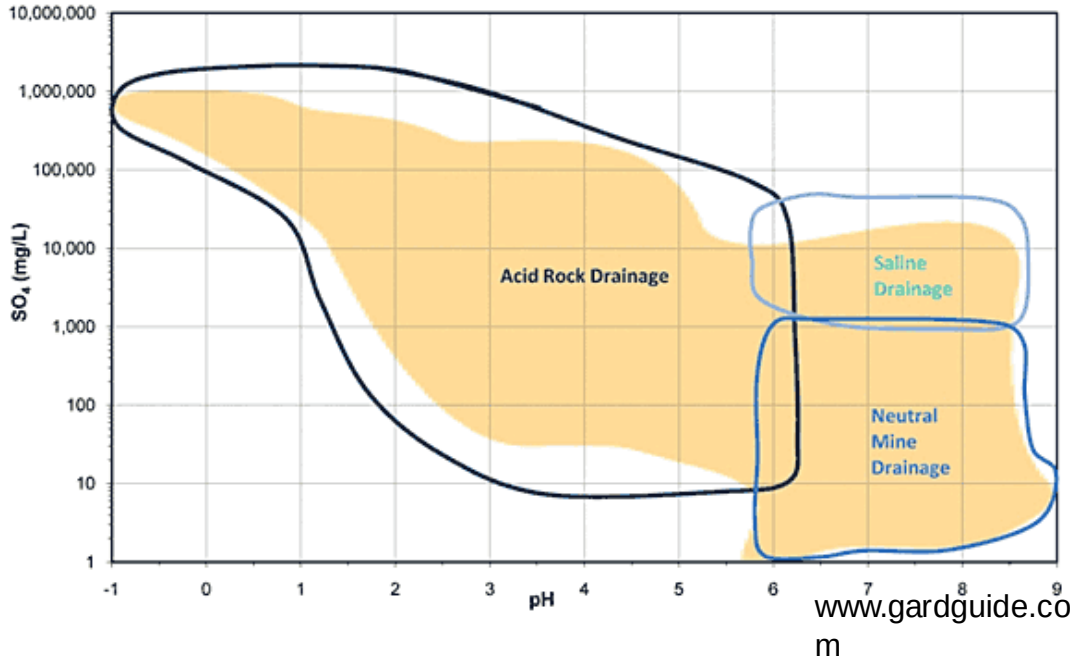
- **pH below 6**

Neutral Mine Drainage (NMD):

- **pH above 6**

Saline Drainage (SD):

- **pH above 6**



www.gardguide.com

The International Network fur Acid Prevention (INAP), 2009. Global Acid Rock Drainage Guide (GARD Guide).http://www.gardguide.com'.

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Mine drainage types

ARD/AMD-like seepage waters (e.g. from waste rock piles):

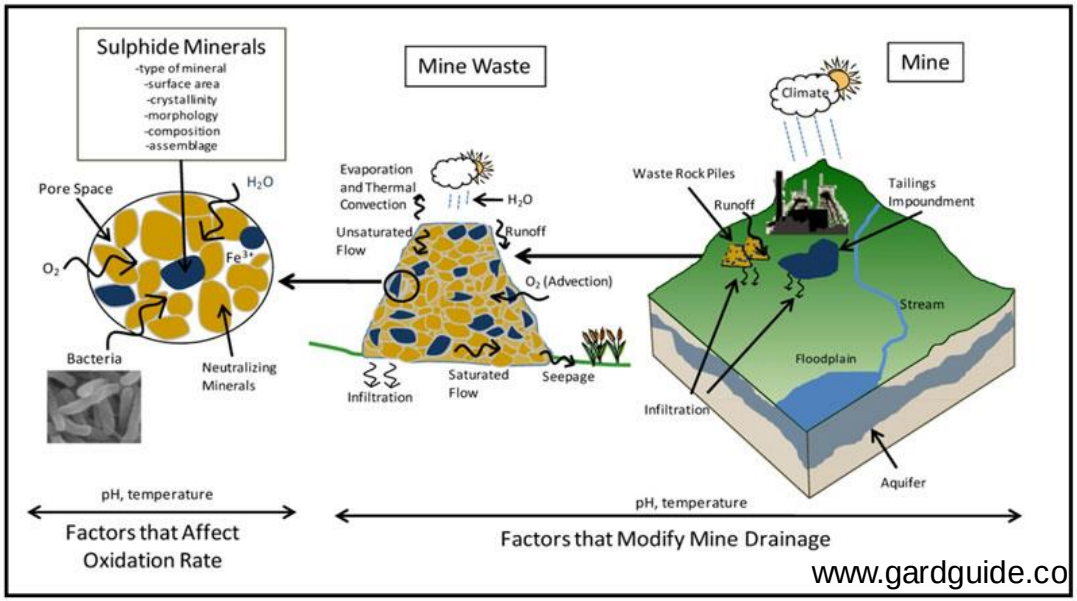
- Pyrite/sulfide minerals
- Water
- Oxygen
- Microbes

→ **Formation of sulphuric acid**

→ **Leaching of metals from minerals**

Global problem

Bioleaching process will continue as long as the drivers exist.



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Mine drainage types

Composition of ARD/AMD-like seepage waters:

- Metal composition is site specific
- pH: < 2 to 6
- Base metals: Fe, Al (pH<5), Mn…
- Precious metals: Co, Cu, Zn, Ni…
- Toxic metals: Pb, U, As…
- REEs (pH<3 & low P?)
- Sulphate

Concentration of iron and sulphate is typically grams/liter.

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Mine drainage types

Seepage waters from tailing ponds, waste piles etc.

- **Stability of tailings/ waste materials –pH, climate conditions…**
- **Elemental composition of tailings/ waste materials – S & Fe**
- **Soluble/sparingly soluble salts – e.g gypsum**
- **Bioleaching ongoing?**
- **Water recycling?**

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Most of precious and toxic metals are much less soluble in neutral and alkaline conditions than in acidic conditions.

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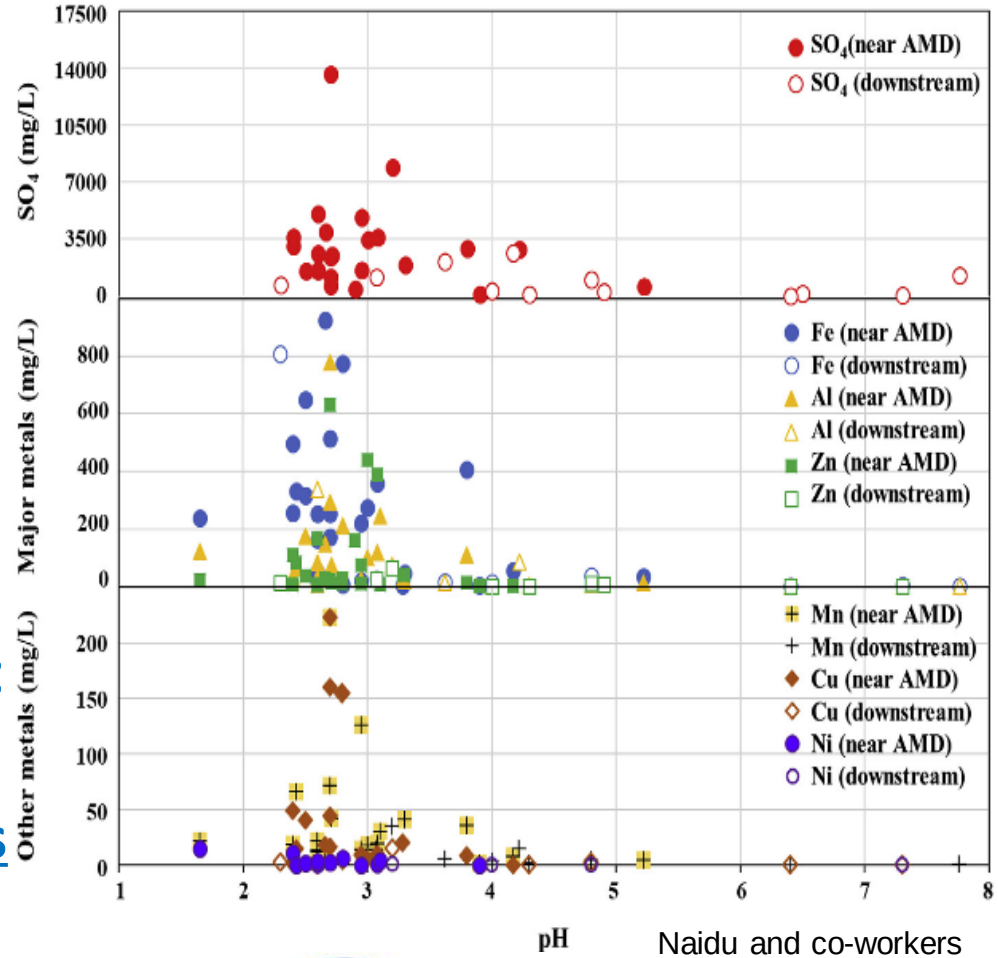
Recovery of metals from mine seepage /drainage waters

A lot of R&D not yet implemented in full scale:

- Valuable elements exist in significantly lower concentration compared to major metals.
- It is hard to selectively separate valuable elements from dominant metals.
- How to recover valuable elements efficiently and economically?



Naidu and co-workers 2019

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Recovery of metals from mine seepage /drainage waters

Things to consider when trying element recovery from waters:

- The lower the water pH the higher levels of dissolved elements will be in most cases.
- E.g. some of the REEs remain precipitated at pH 1!
- Levels of dissolved elements are highest at the formation site – seepage water may be chemically unstable – Iron!
- Seasonal variation

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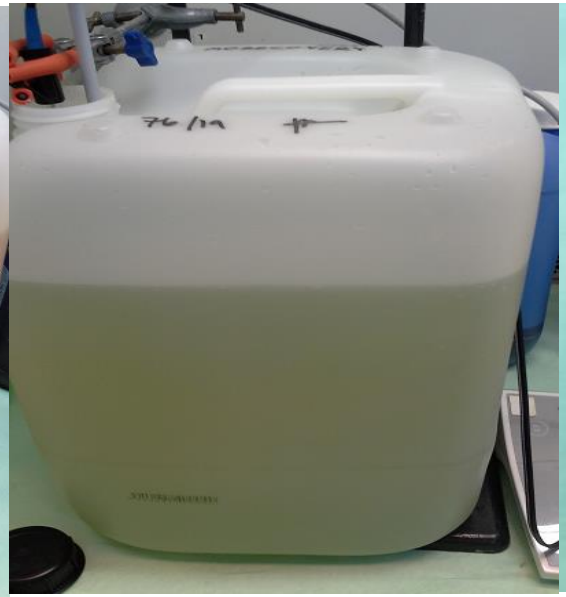
Recovery of metals from mine seepage /drainage waters

Two scenarios:

1) Specific recovery from seepage/drainage water
2) Recovery from water treatment sludge



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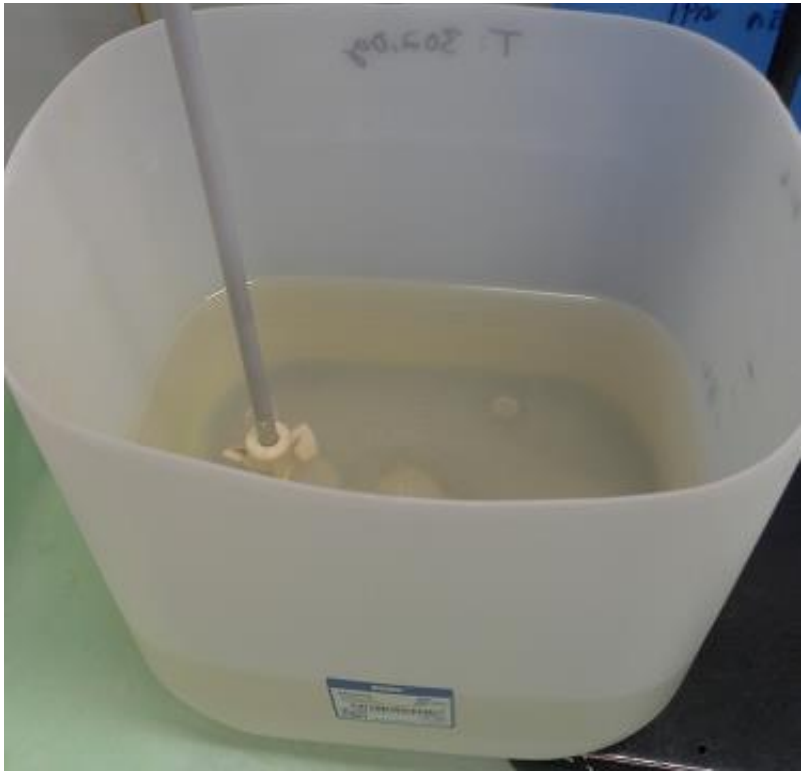
Hitura drainage water

Seepage/infiltration water from tailings pond

- pH: about 5,9-6
- Sulphate: 6300-7500 mg/l
- Magnesium: 1700-2000 mg/l
- Chloride: 1400-1550 mg/l
- Calcium: 410-470 mg/l
- Iron: 220-300 mg/l
- Nickel: 20-23 mg/l
- Cobalt: 10-11,7 mg/l
- Water unstable – Iron oxidation

➢ **features of AMD and SD**



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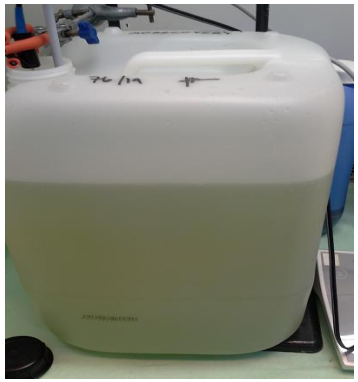
Recovery of Ni&Co from Hitura drainage water



Hitura drainage water (Fe&Ni&Co)

↓

Oxidation and precipitation of iron

↓

Solid separation → **Iron sludge**

↓

Water with Ni&Co

↓

Precipitation of Ni&Co

↓

Solid separation → **Ni&Co sludge**

↓

Water residue for discharge

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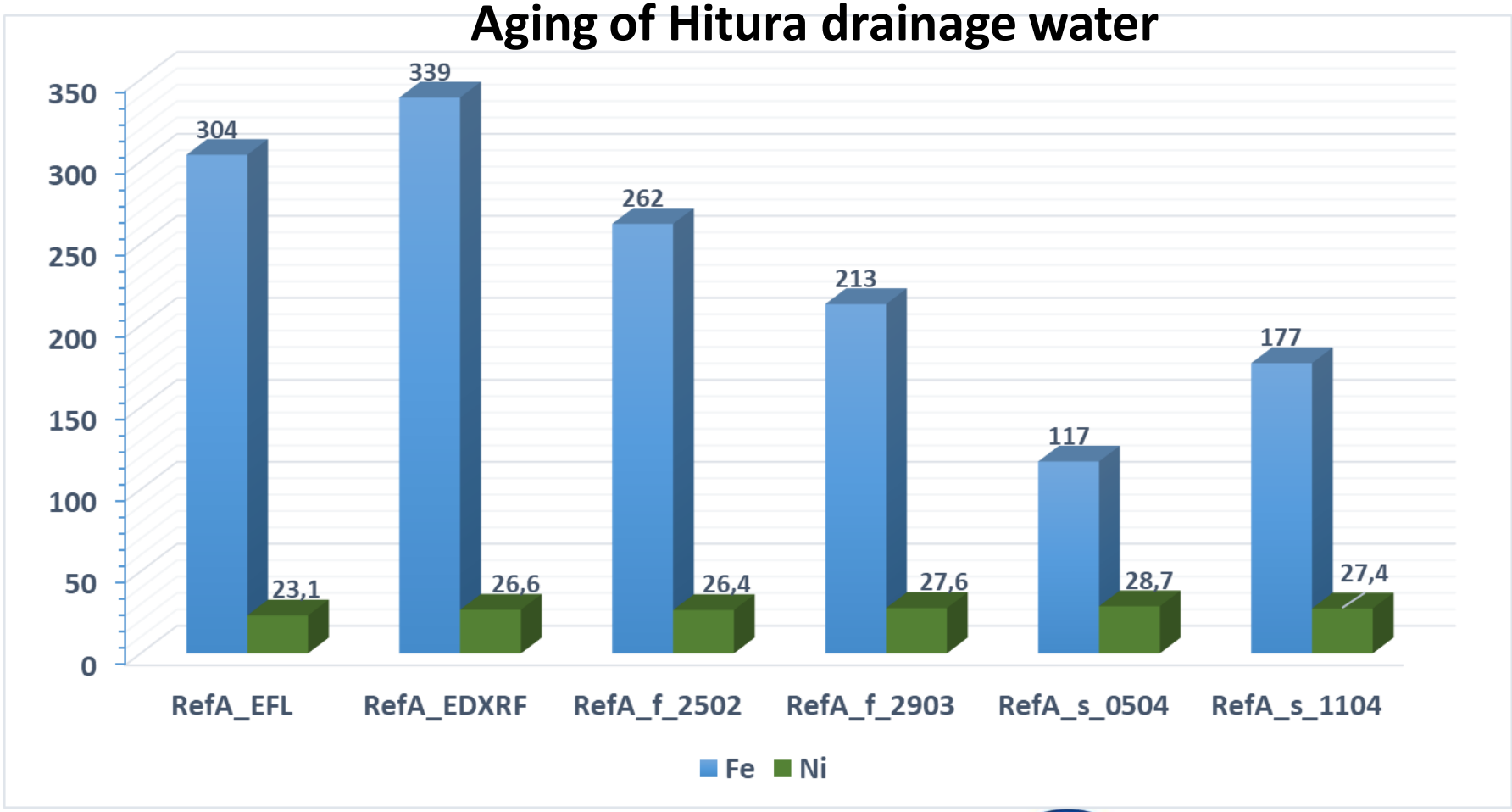

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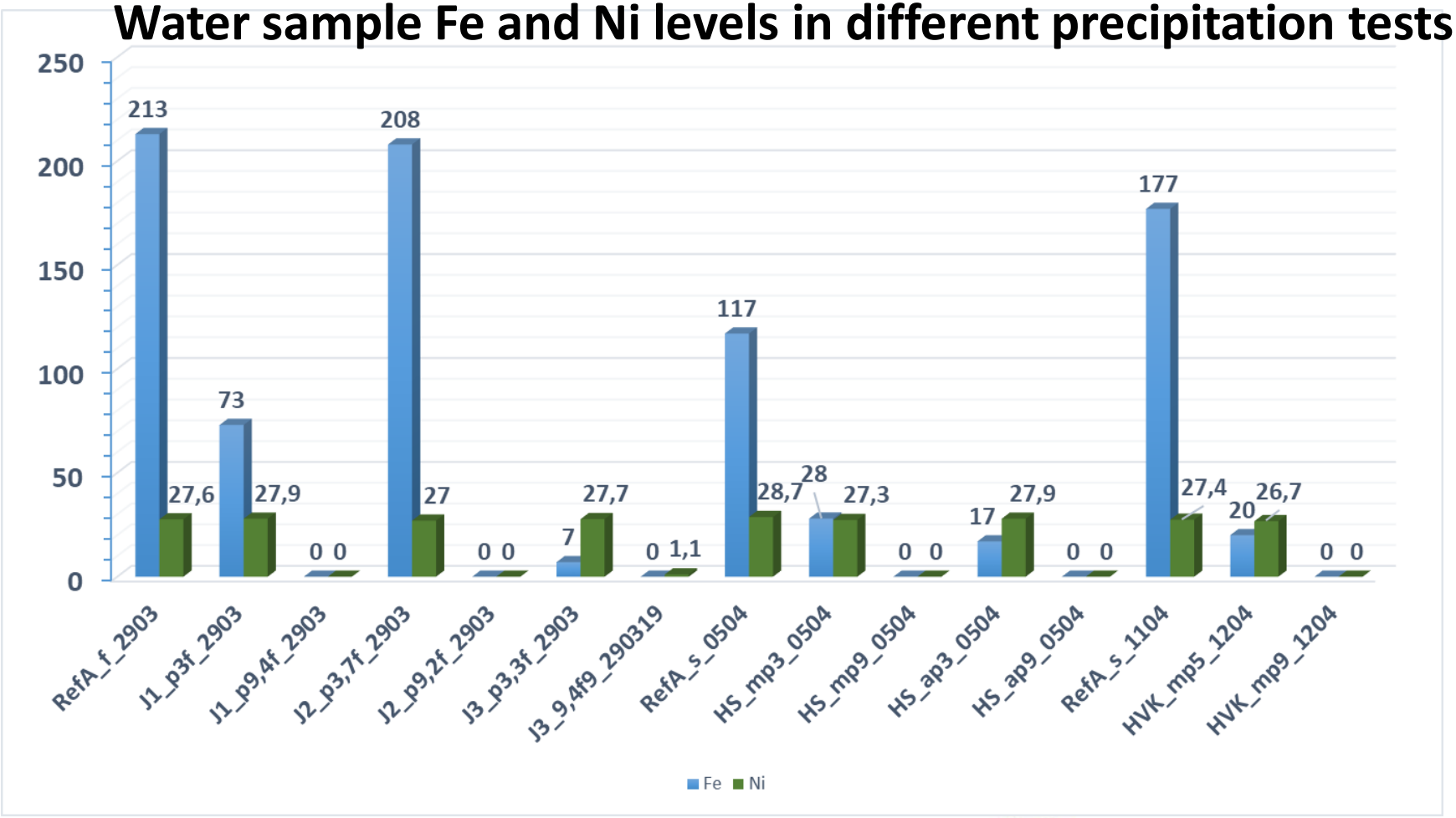
Recovery of Ni&Co from Hitura drainage water

Water sample Fe and Ni levels in different precipitation tests



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Recovery of Ni&Co from Hitura drainage water

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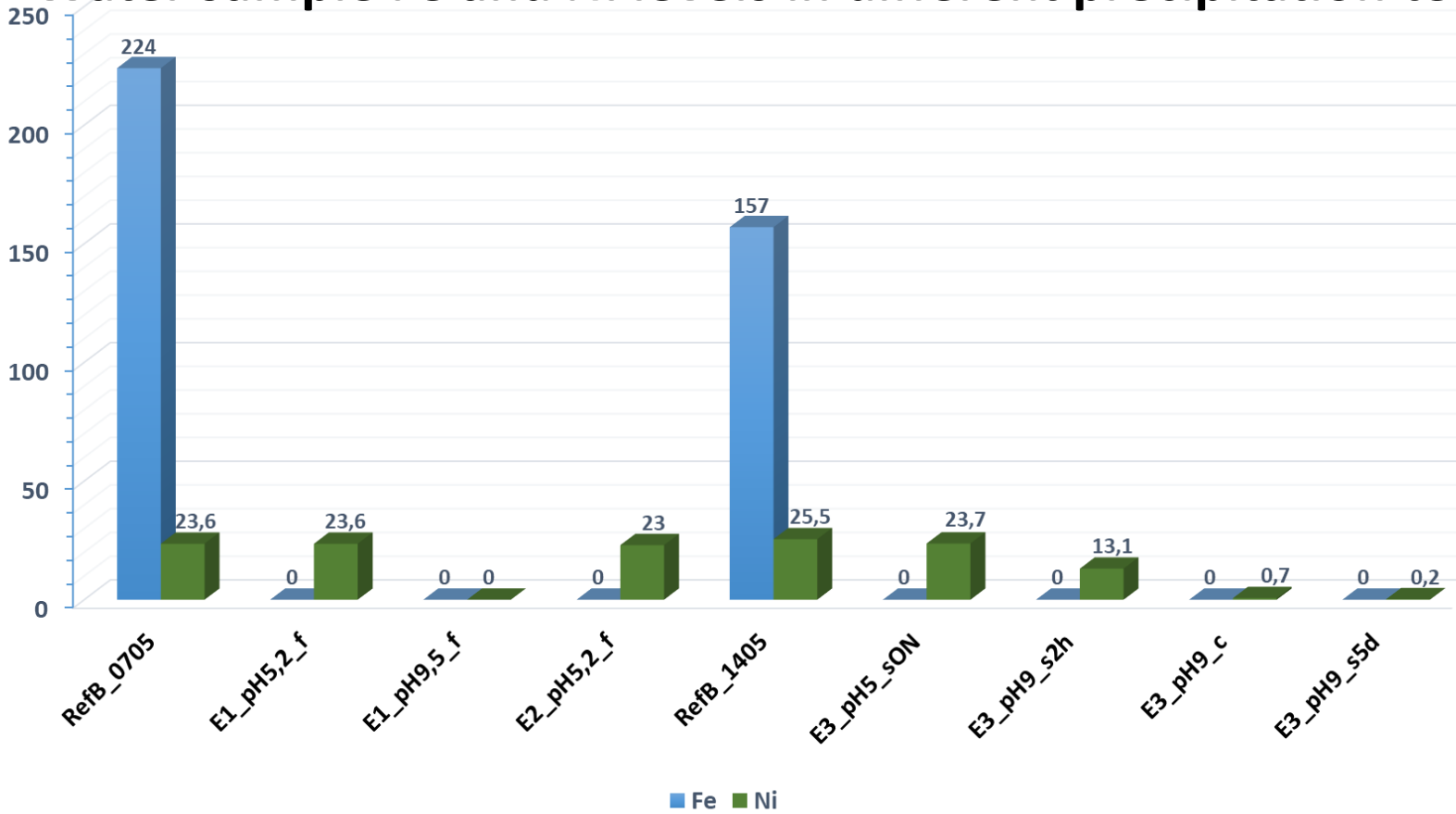

E3: p5 sludge 260 ml/22 l water (56 ml after cf) and p9 sludge 37 ml after cf (20 l water)

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Recovery of Ni&Co from Hitura drainage water

Laboratory method has been tested with two water samples (Feb 2019 and May 2019), batch tests.

Optimization to be done for Ni & Co precipitation at temperature close to 5 °C (precipitation efficiency & sludge separation) – laboratory tests planned for late Autumn 2019.

→ Ni & Co recovery will be piloted from Hitura seepage water in 2020.

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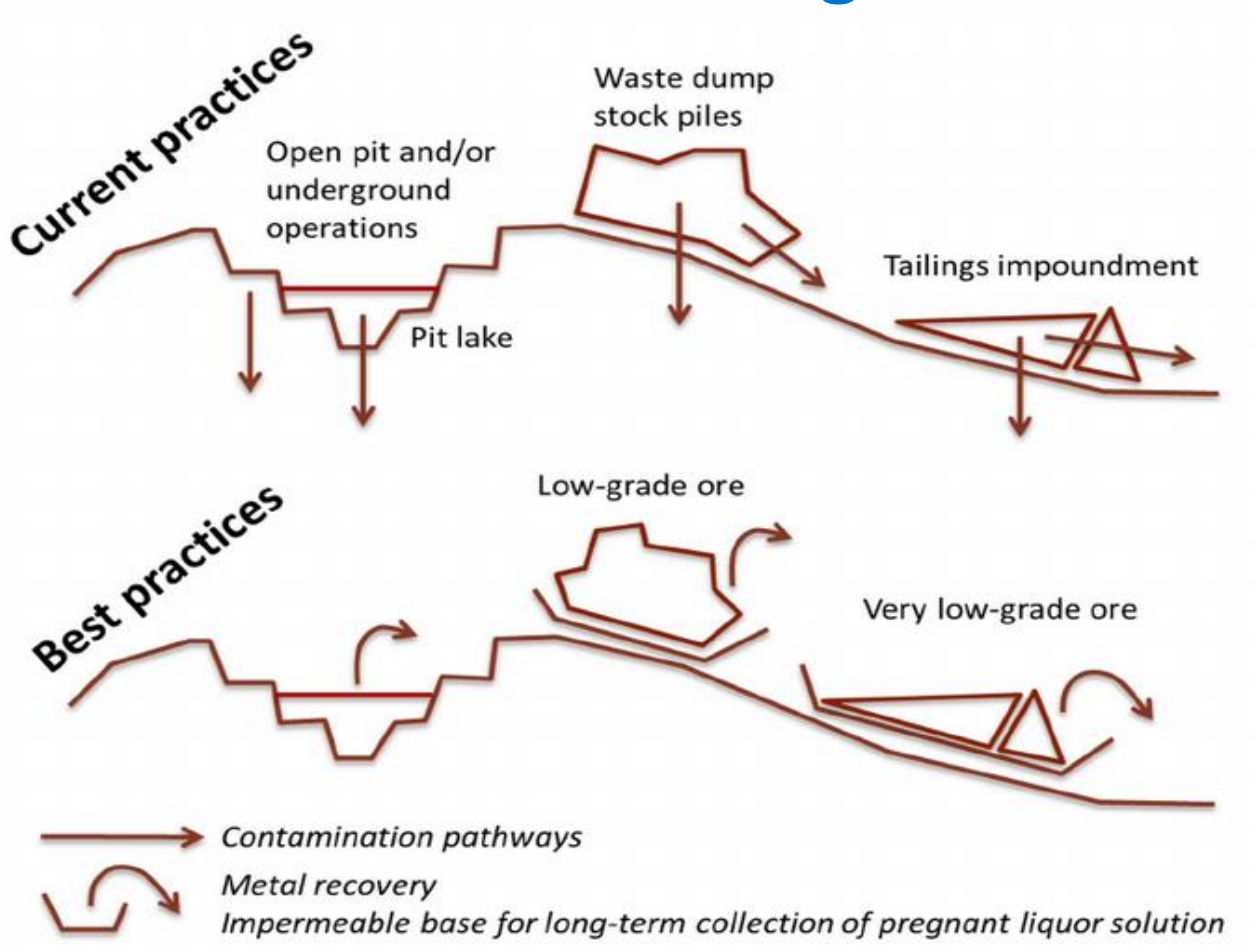
Future of mining?



Modified from Lèbre and Corder 2015, *Resources* **2015**, *4*, 765-786

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Thank You!

Questions?

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