Nickel laterites

Grade definition and process optimization by mineralogical monitoring using XRD

Uwe König, The Netherlands, uwe.koenig@malvernpanalytical.com

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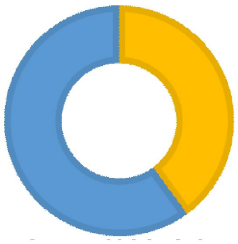
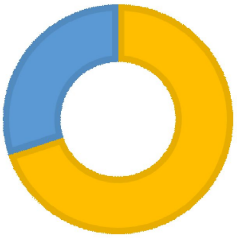
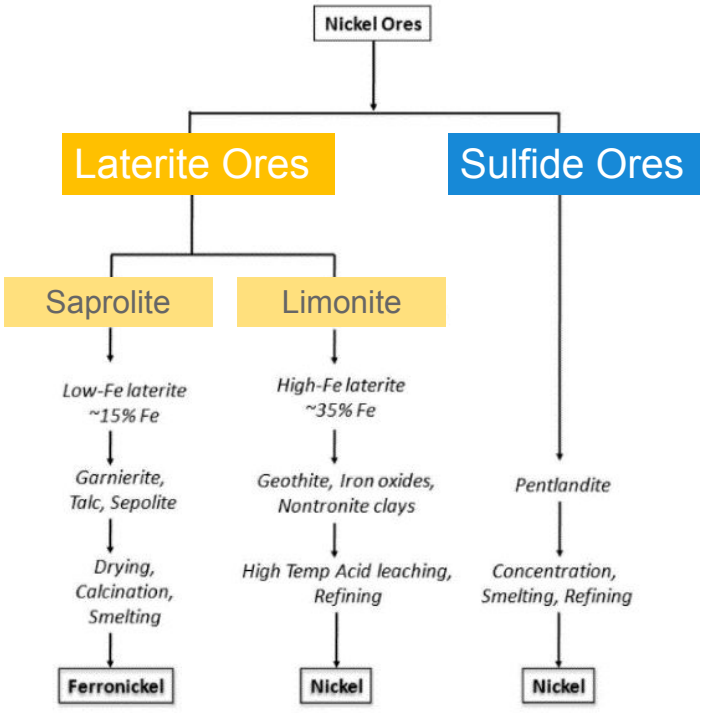
Types of nicke

Lateritic vs sulfidic



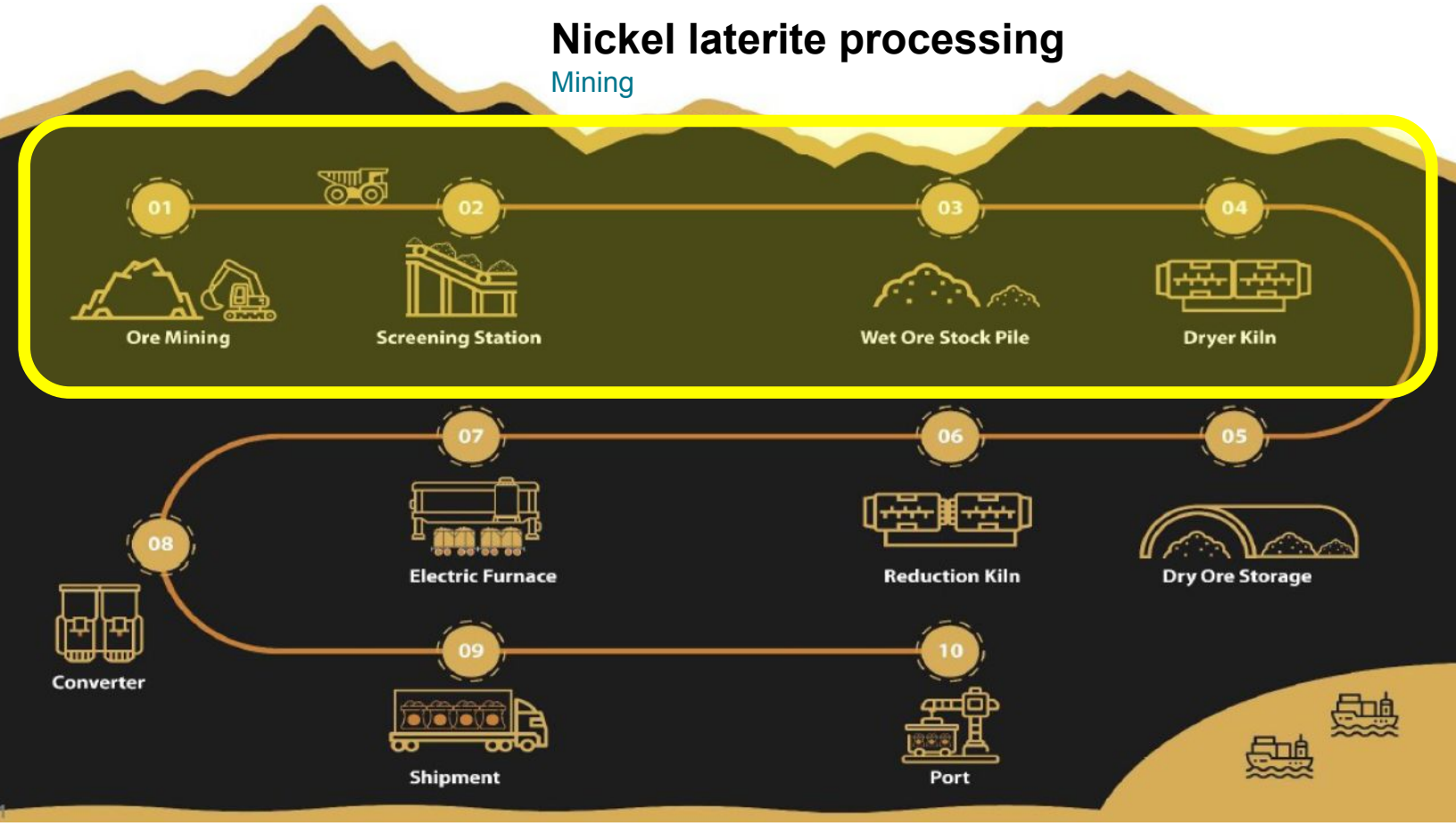




2011)

Nickel laterite processing

Mining



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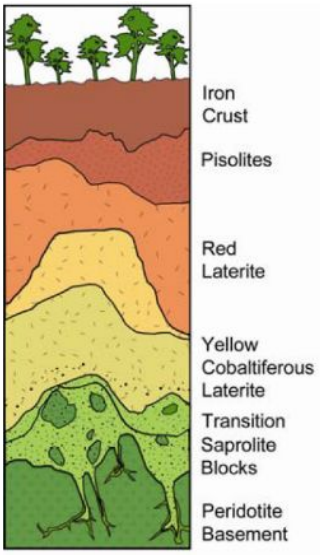
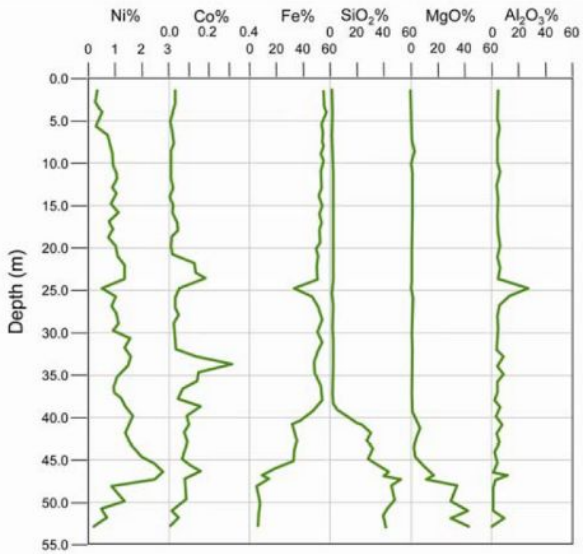
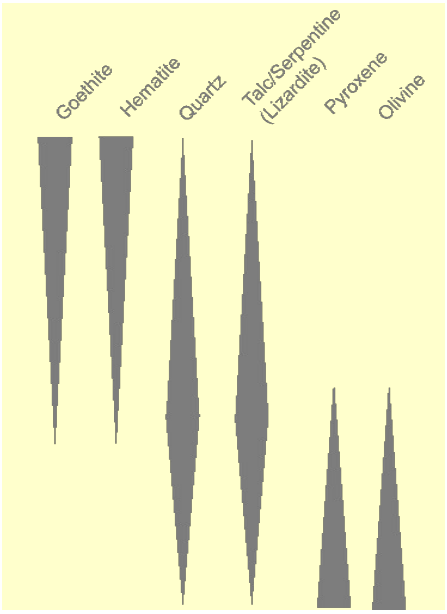
Schematic hydrous Mg-Si-silicate laterite profile



(Goro Nickel, 2006)





Nickel laterites

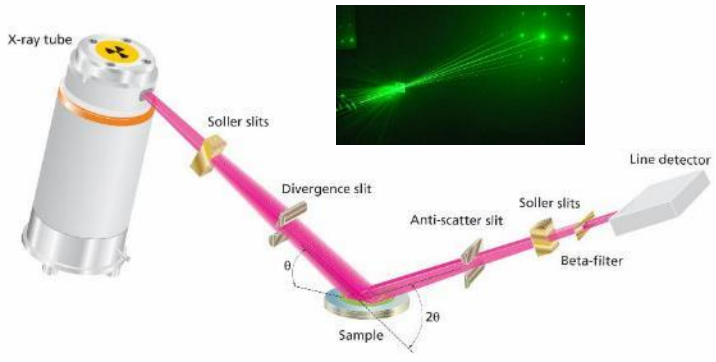
Samples

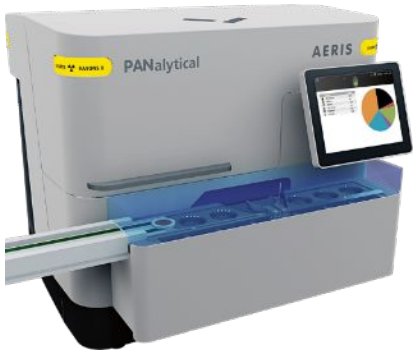
40 nickel laterite samples prepared for XRD measurements representing five main groups in the nickel laterite profile, left = high goethite, right = high lizardite

X-ray diffraction (XRD)

How does it work ?

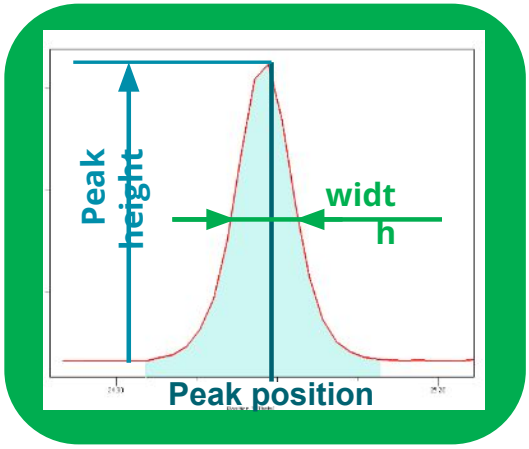
- Identification and quantification of crystalline phases and amorphous content
- Monitoring of process parameters





X-ray diffraction (XRD)

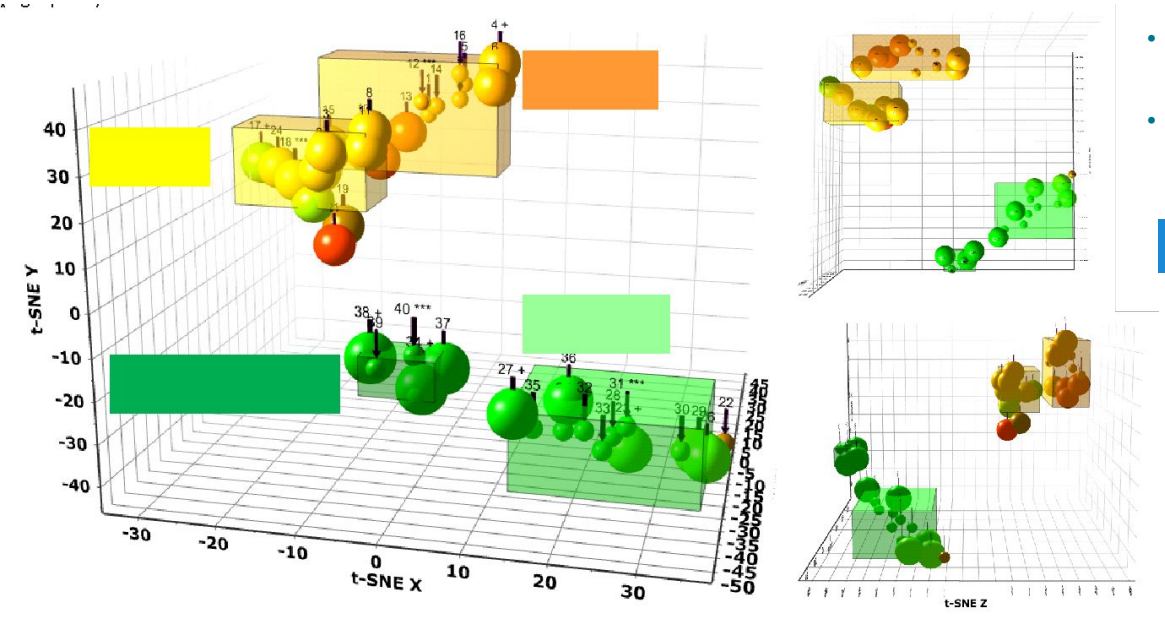
Mineralogy and more ….



- Phase composition
- Amorphous content
- Crystallite size/microstrain
- Structural information
- Process parameters

Nickel laterites

Cluster analysis for ore sorting



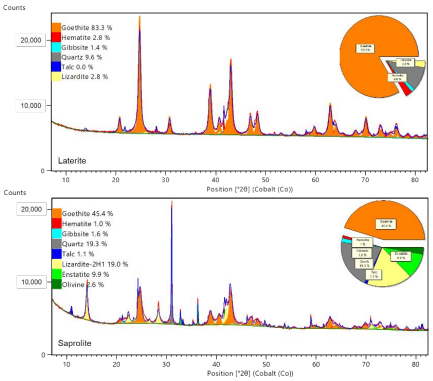
- 40 powder samples
- Clear separation between laterite and saprolite ores

Measurement time 5 min

Nickel laterites

Mineral identification / quantification

Mineral	Formula
Goethite	FeOOH
Hematite	Fe_2O_3
Gibbsite	$Al(OH)_3$
Quartz	SiO_2
Lizardite	$(Mg,Ni)_3(Si_2O_5)(OH)_4$
Talc	$Mg_3[(OH)_2Si_4O_{10}]$
Enstatite (Pyroxene)	$Mg_{15.44}Ca_{0.56}Si_{16}O_{48}$
Forsterite (Olivine)	$Mg_{7.17}Fe_{0.8}Ni_{0.02}Mn_{0.01}Si_4O_{16}$



Nickel laterites

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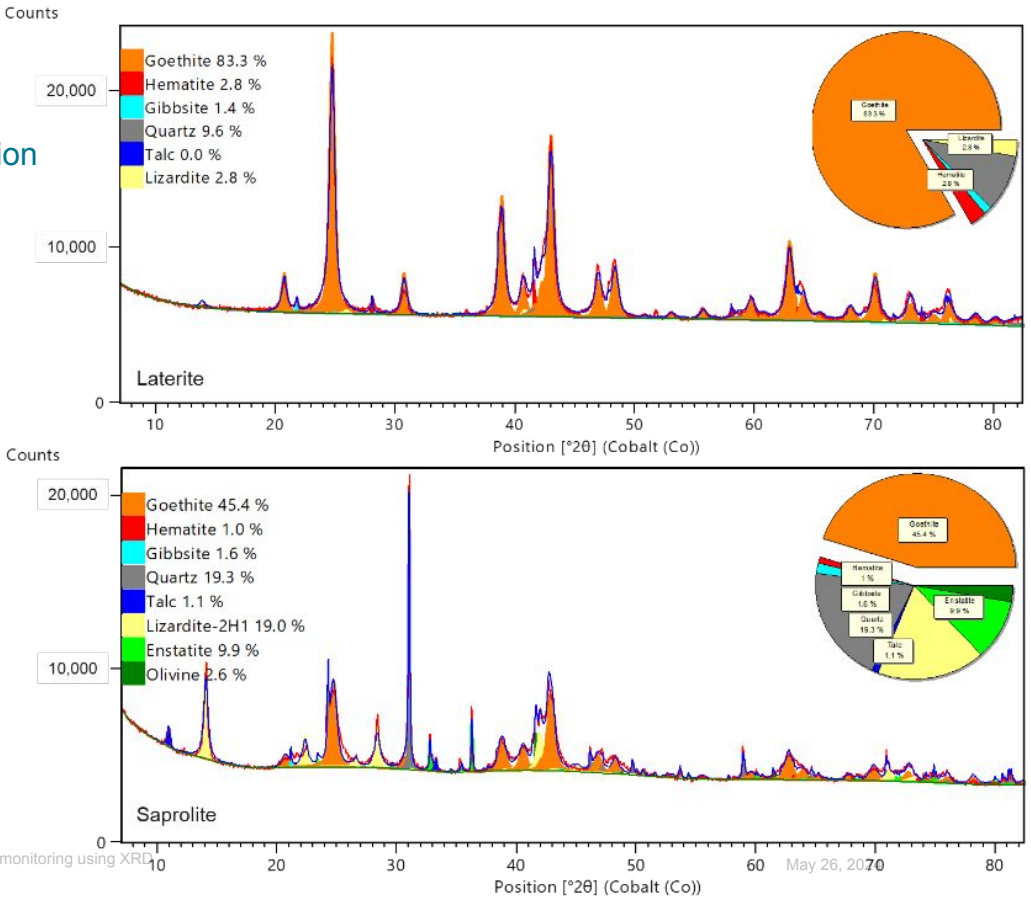

Nickel laterites

Mineral quantification

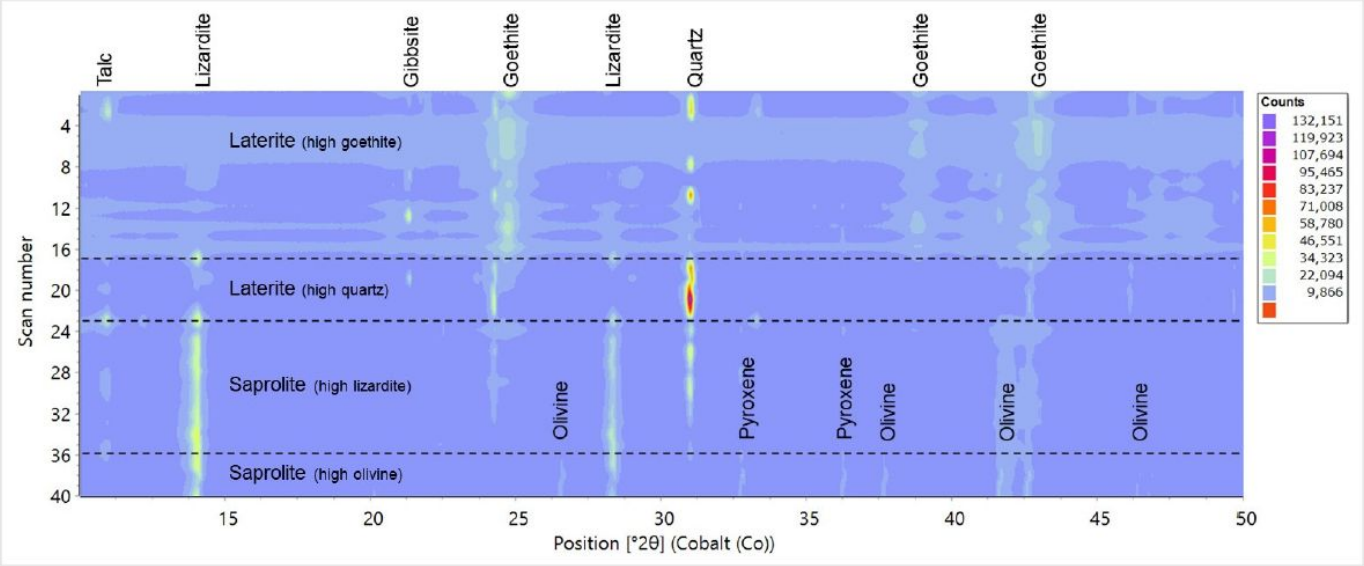

Figure 8. XRD scan surface plot of the region between 10° 2θ and 50° 2θ showing intensities of the main mineral phases.

May 26, 2024

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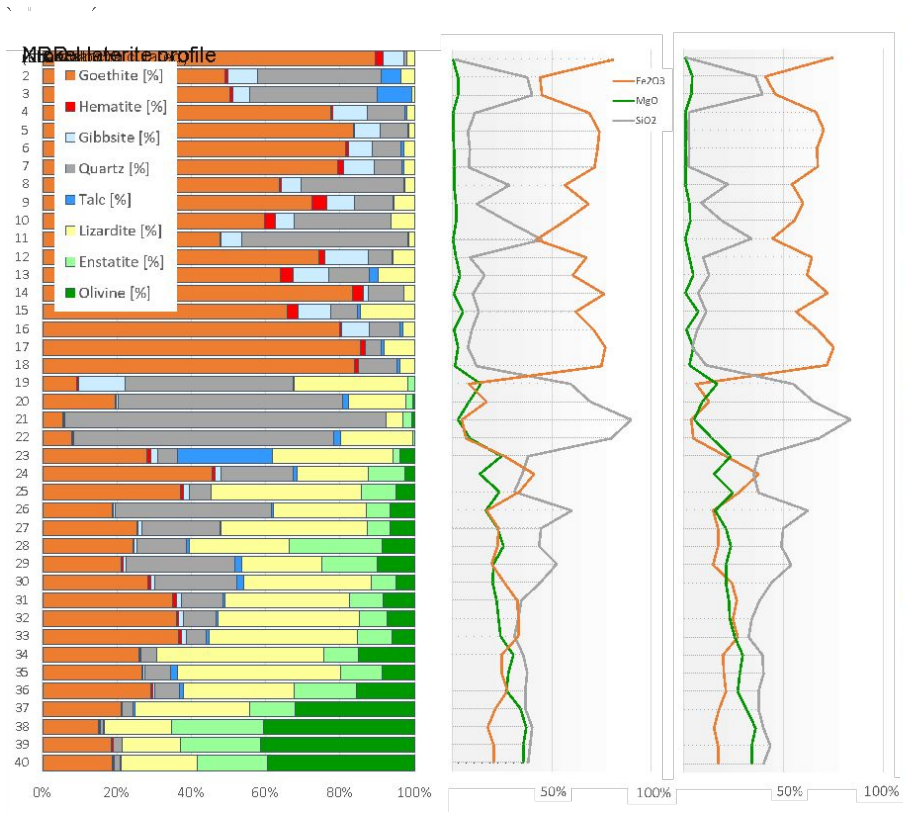
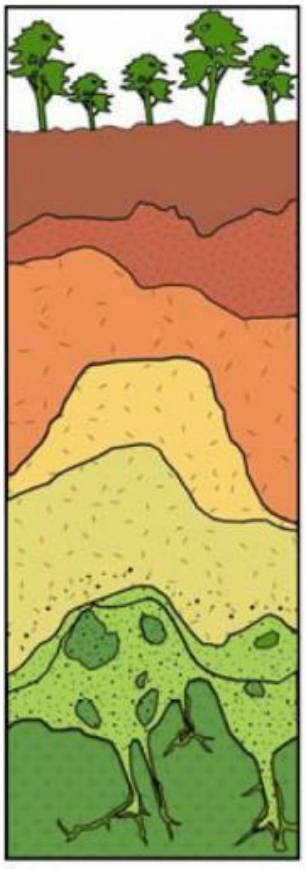
Mineral quantification



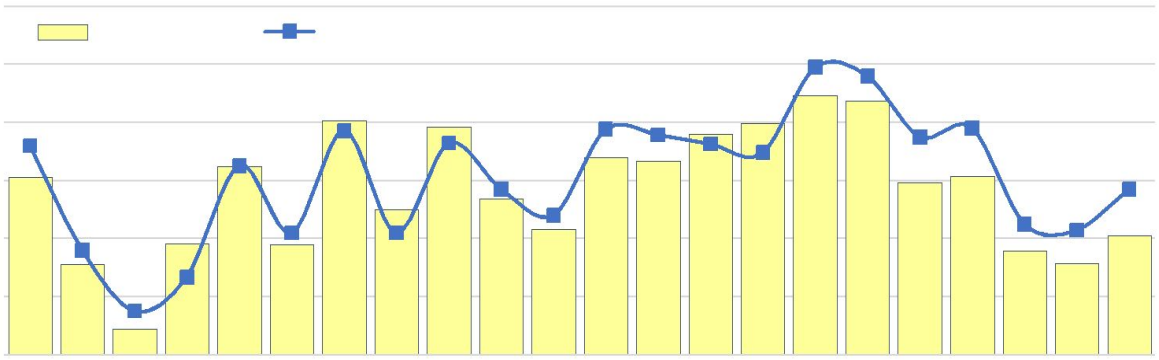


Mineralogical and elemental composition of 40 samples from a hydrous Mg-Si-silicate laterite profile

Nickel laterites

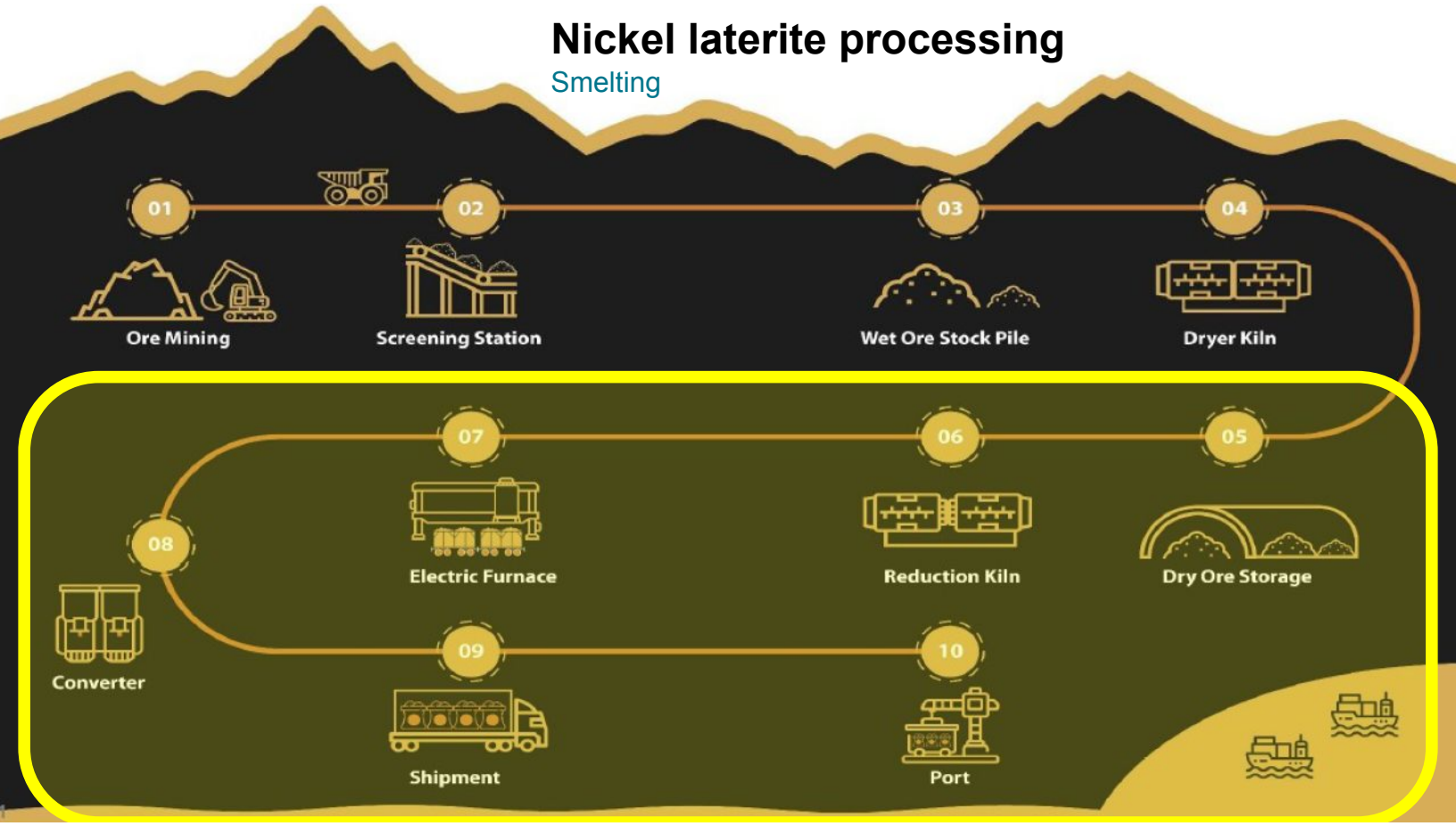
Lizardite and nickel content

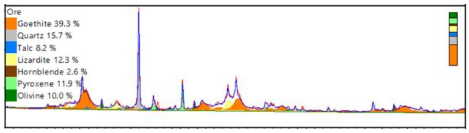
- Comparison of the amount of lizardite (XRD) and the nickel content (XRF) in the saprolitic samples of the profile

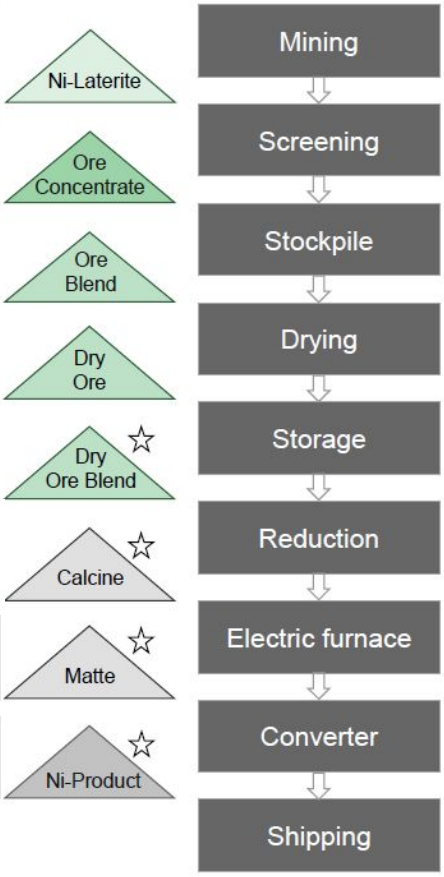


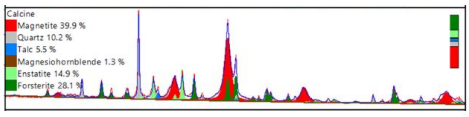
Nickel laterite processing

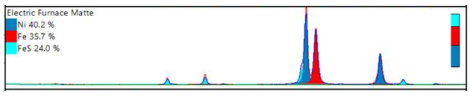
Smelting

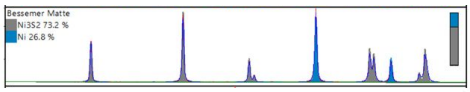


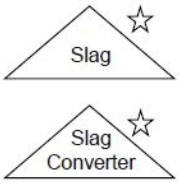


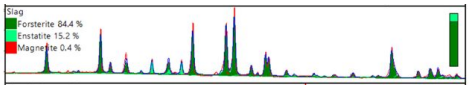












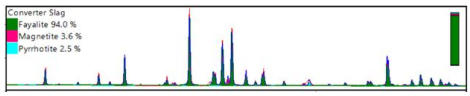


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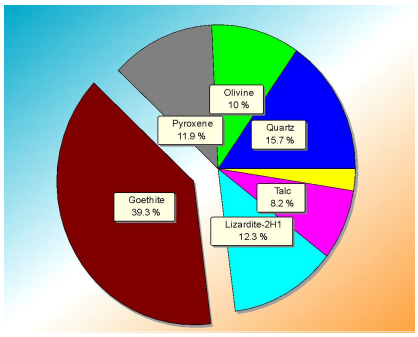
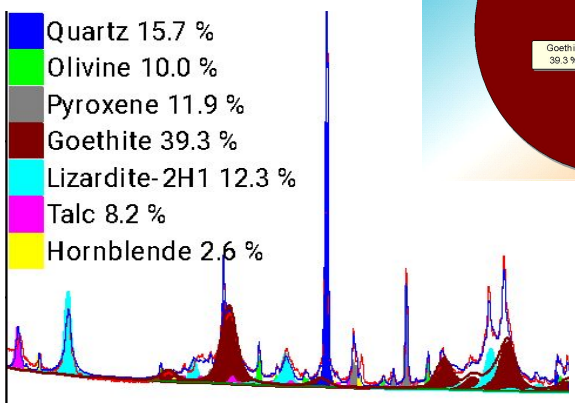
Table 4. Identified minerals in the process samples.

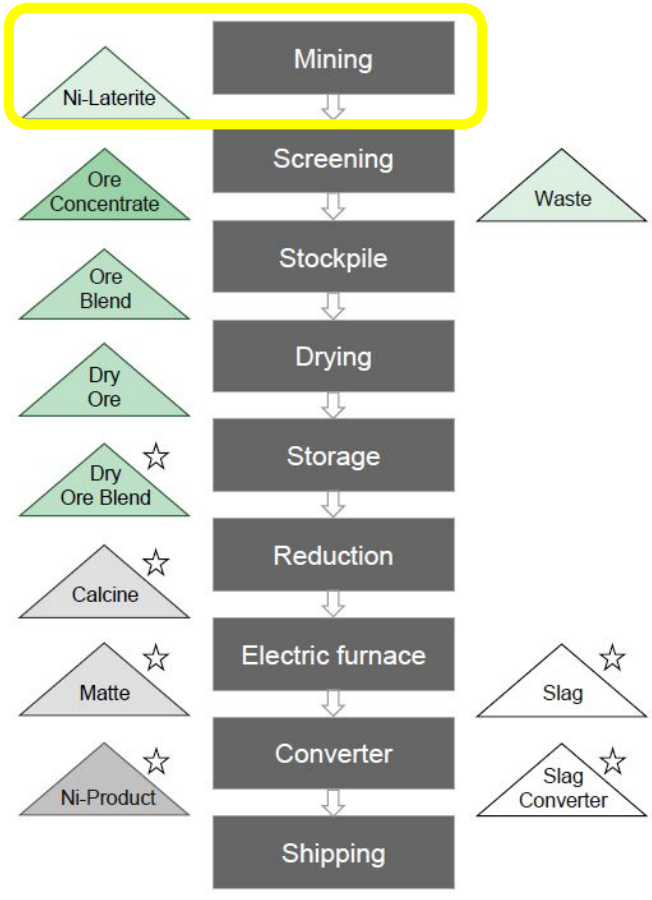
Mineral	Formula
Magnetite	Fe_3O_4
Hornblende	$(Ca,Na)_{2-3}(Mg,Fe,Al)_5(Al,Si)_8O_{22}(OH,F)_2$
Pyrrhotite	$Fe_{(1-x)}S$
Fayalite (Olivine)	Fe_2SiO_4
Nickel	Ni
Heazlewoodite	Ni_3S_2
Iron	Fe
Troilite	FeS

Nickel laterite processing

Ore

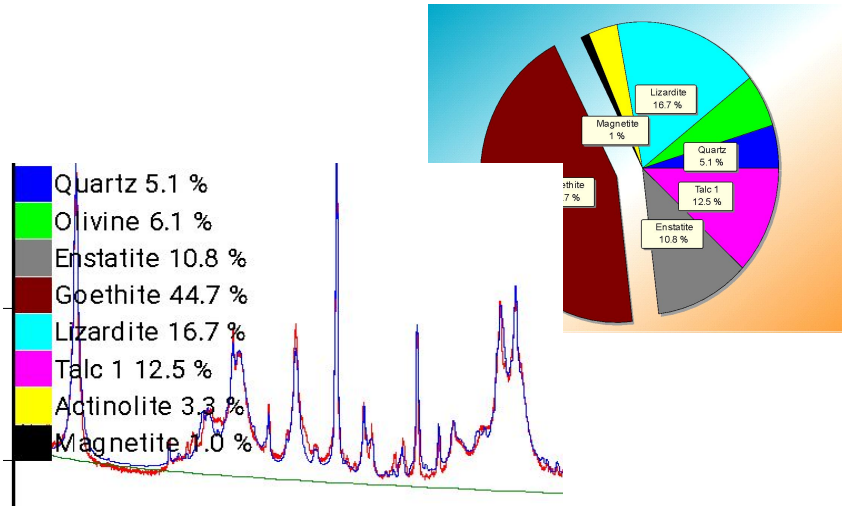


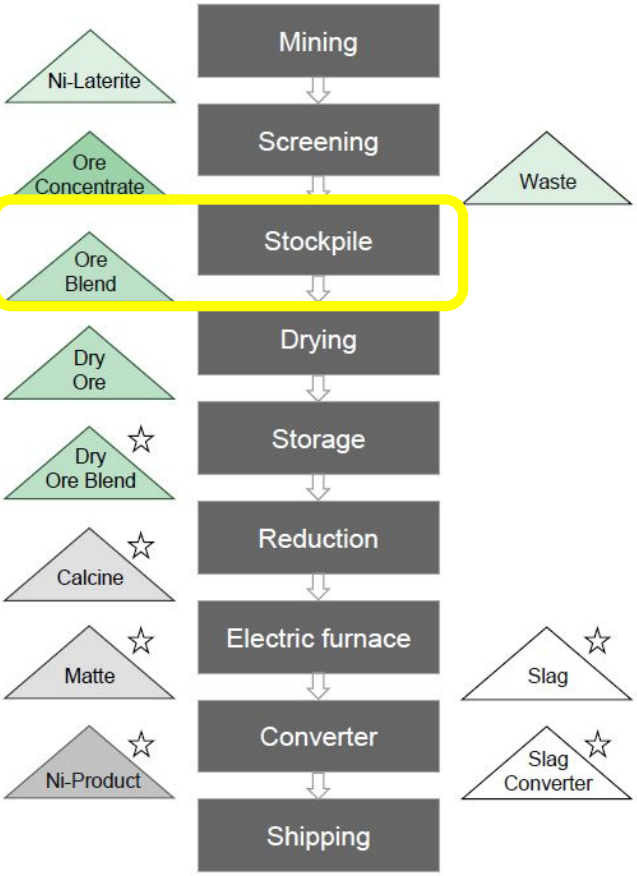




Nickel laterite processing

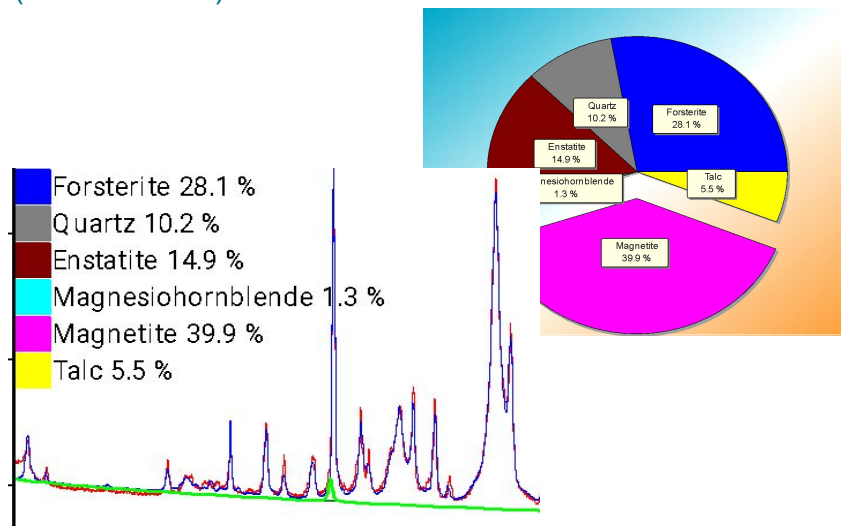
Blending

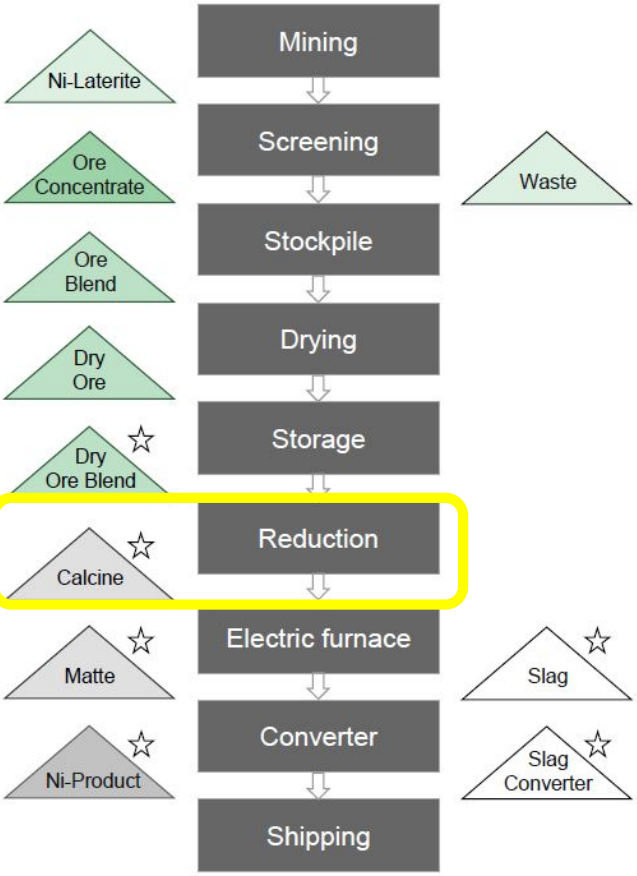




Nickel laterite processing

Roasting, Dehydration (Pre-reduction)





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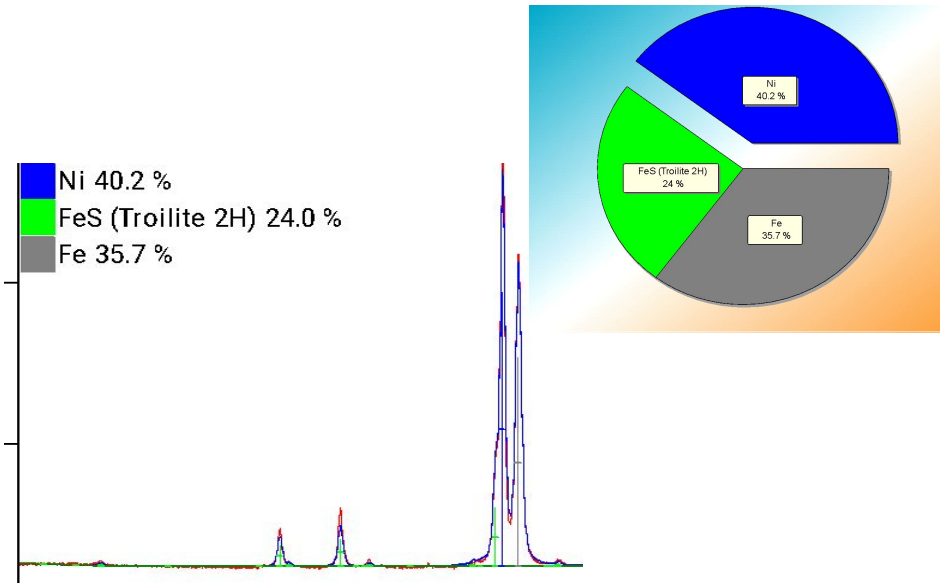
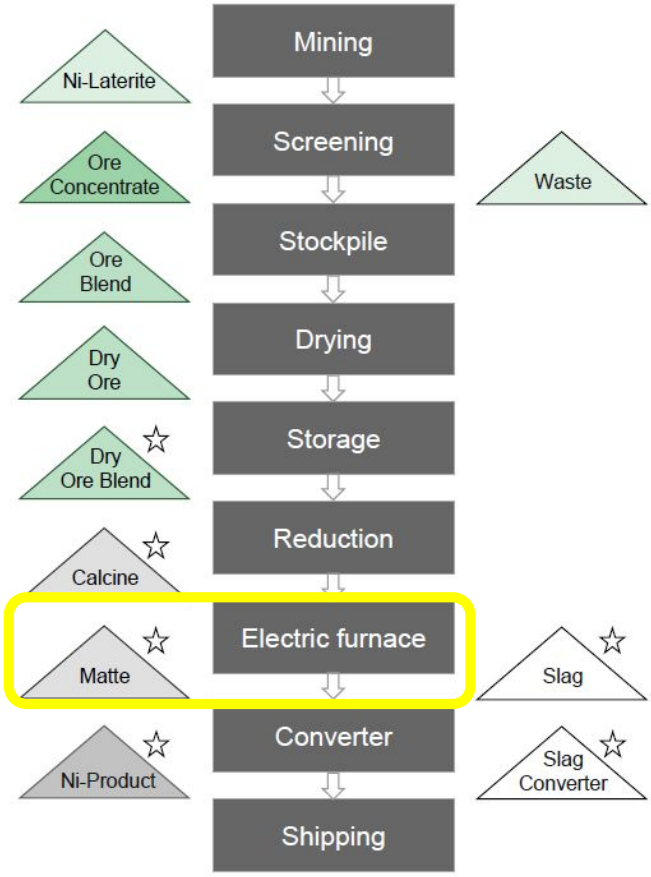
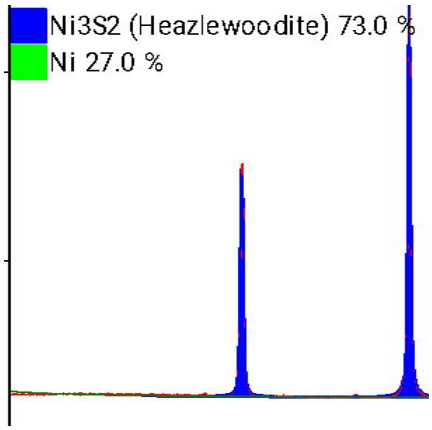
Matte (Sulphur addition)

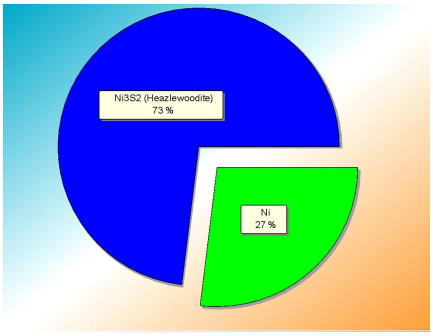


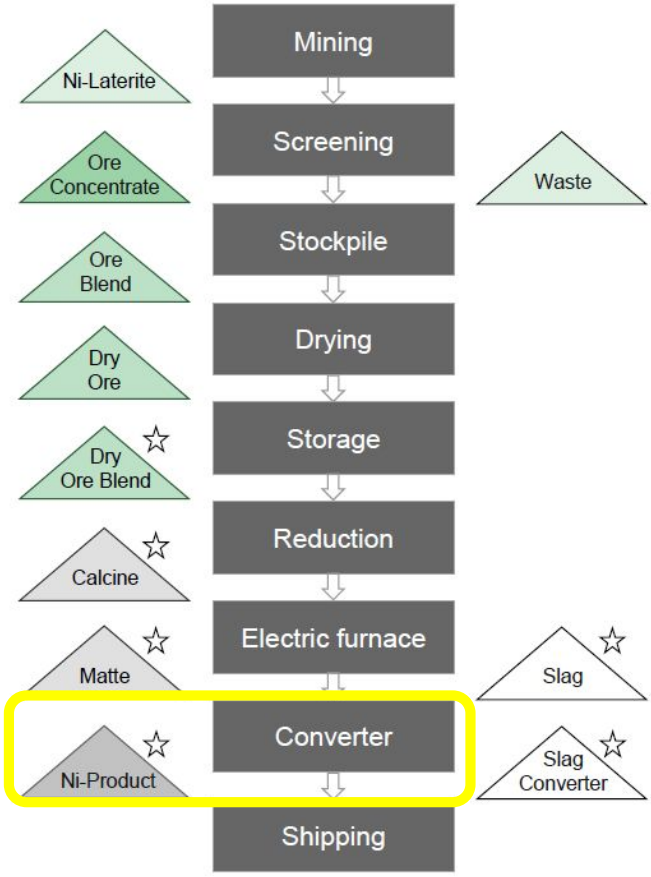


Nickel laterite processing

Product







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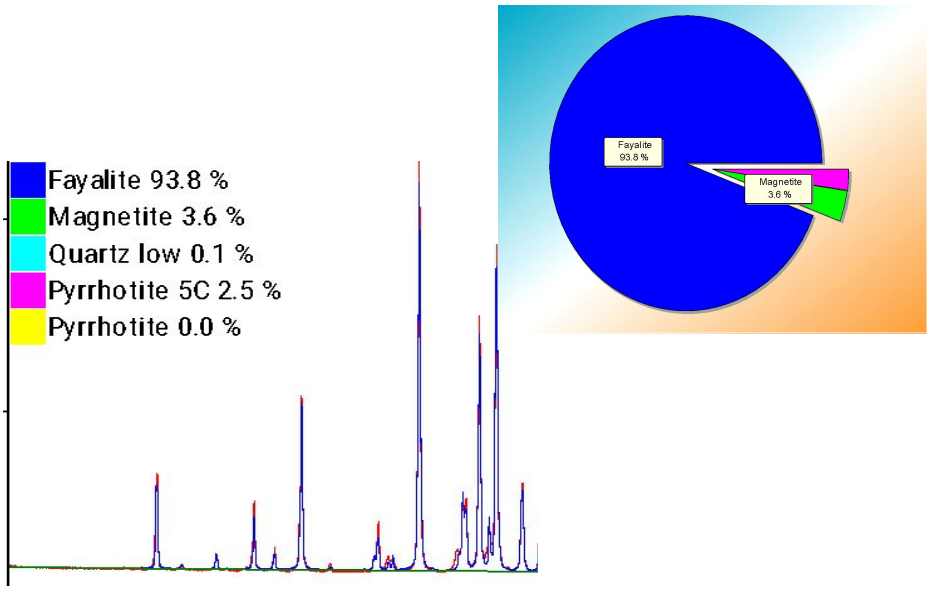
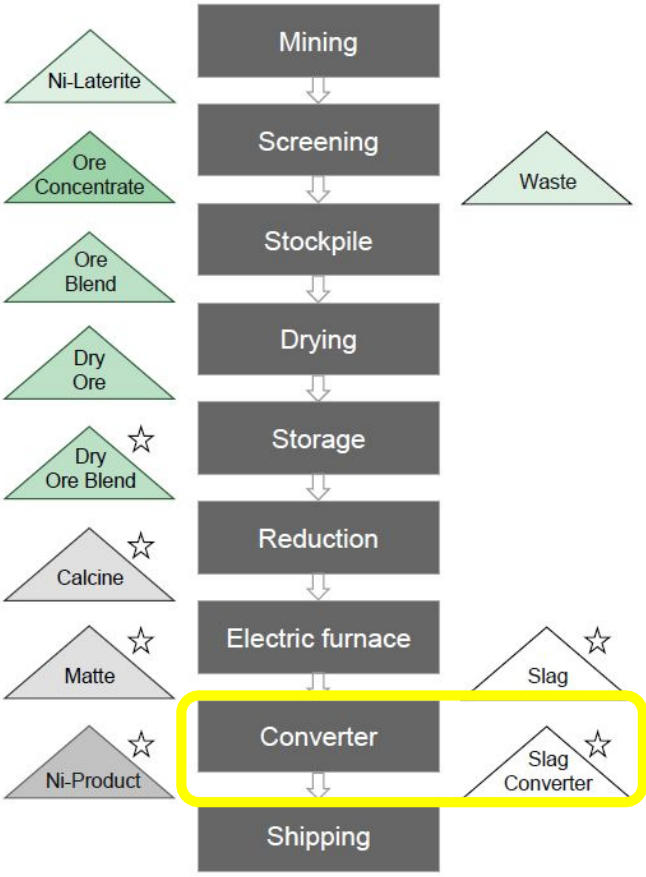
Converter slag





Value of mineralogical monitoring

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Value	XRD - Tool
Optimization of ore blends from various nickel laterite deposits	Cluster analysis
Adjustment of superheat in the feed and optimization of energy costs	Mineralogy of ore blend
Control of mineralization acidity	Silicate composition
Prevention of highly corrosive slag causing erosion of the refractories	Silicate composition
Better reducibility in the furnace	Olivine content
Boost nickel recovery rates and reduction of metal loss in slag	Slag composition
Increase of cobalt recoveries	Co-bearing minerals

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Suited for industrial environments

Aeris Benchtop diffractometer

- No need to access optical path for routine operation
  - No tampering
  - Good dust protection
- External sample loading makes automation very easy

Open Access Article

Nickel Laterites—Mineralogical Monitoring for Grade Definition and Process Optimization

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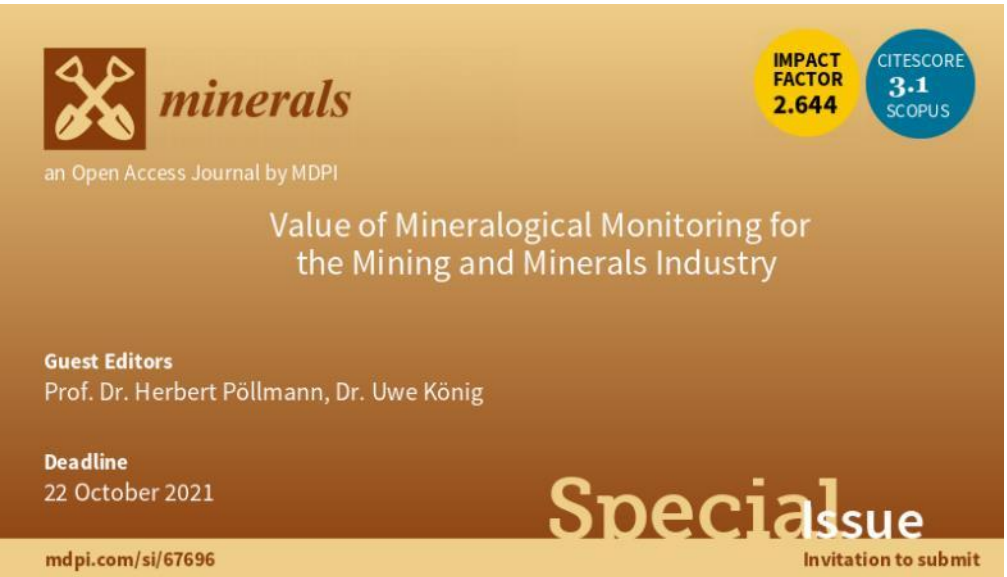
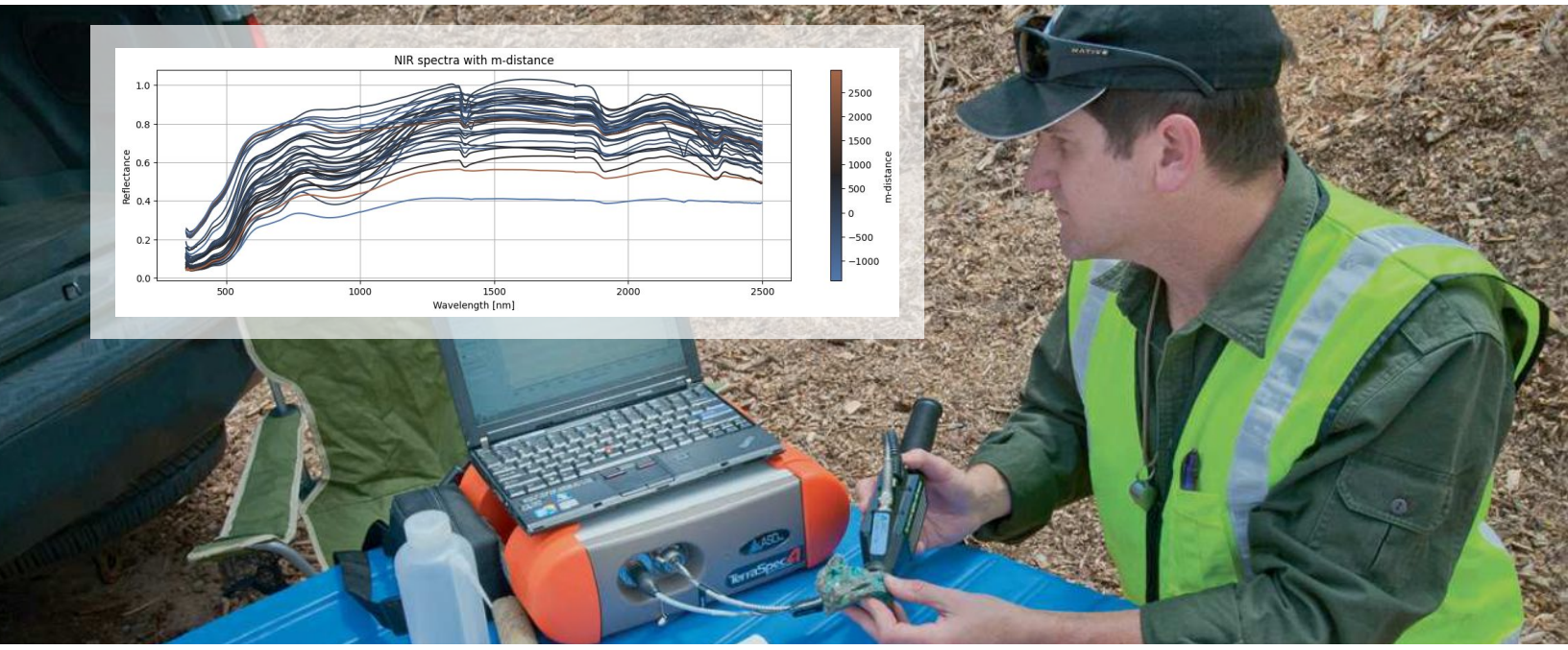


https://www.mdpi.com/1327496

NIR chemometric modelling

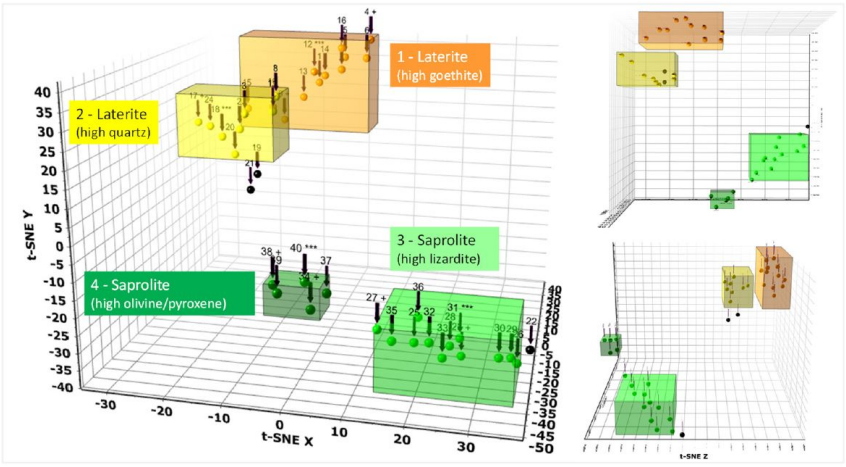
Nickel Laterites



NIR chemometric modelling

XRD mineral composition comparison.

XRD



NIR

NIR chemometric modelling

Nickel Laterites – Single Assay Models

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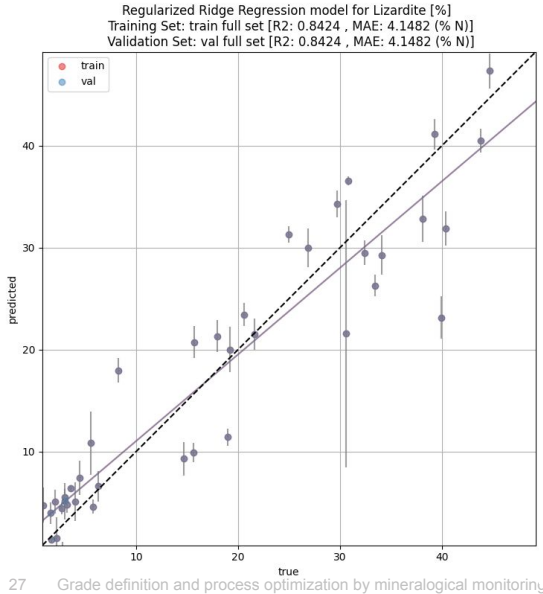
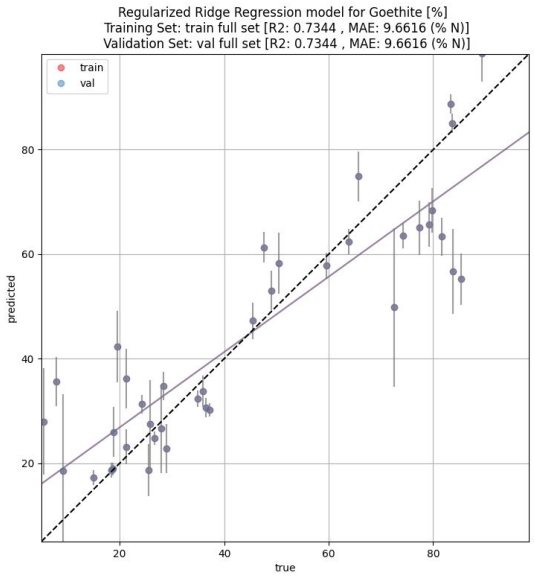
Lizardite



Goethite



4 fold models trained on 30 samples and 10 test samples.
No data was held out for testing, performance on whole training set.

Acknowledgement:
Ed Morris, Malvern Panalytical
Evelien Rost, Malvern Panalytical