

Bioprocessing of Laterites in Brazil: How Bioleaching Can Revolutionize Cobalt Recovery in Brazil

José Luciano Stroppler



COLLABORATING INSTITUTIONS

*Project: Recovery of Cobalt and Lateritic Nickel
by Reductive Bioprocessing in Brazil (BioProLat)*



Geological Survey of Brazil – SGB
Department of
Mineral Resources (DEREM)
Brazil



German Mineral
Resources Agency – DERA
Within the scope of BGR
Germany



Centre for Mineral
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G.E.O.S. Ingenieurgesellschaft mbH
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INDUSTRY PARTNERS



AngloAmerican
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BRAZILIAN
NICKEL

by IA

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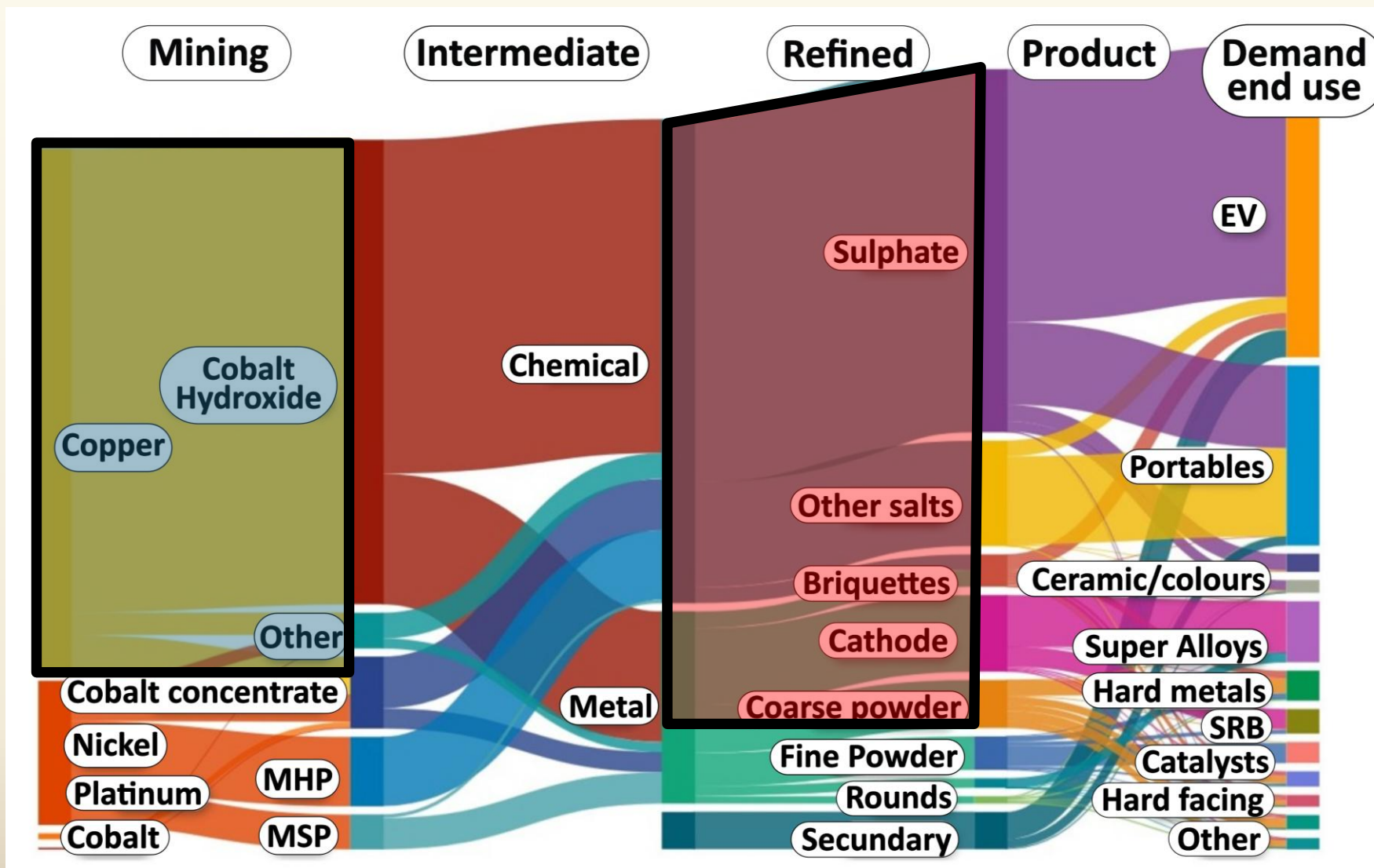
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European Market Opportunities

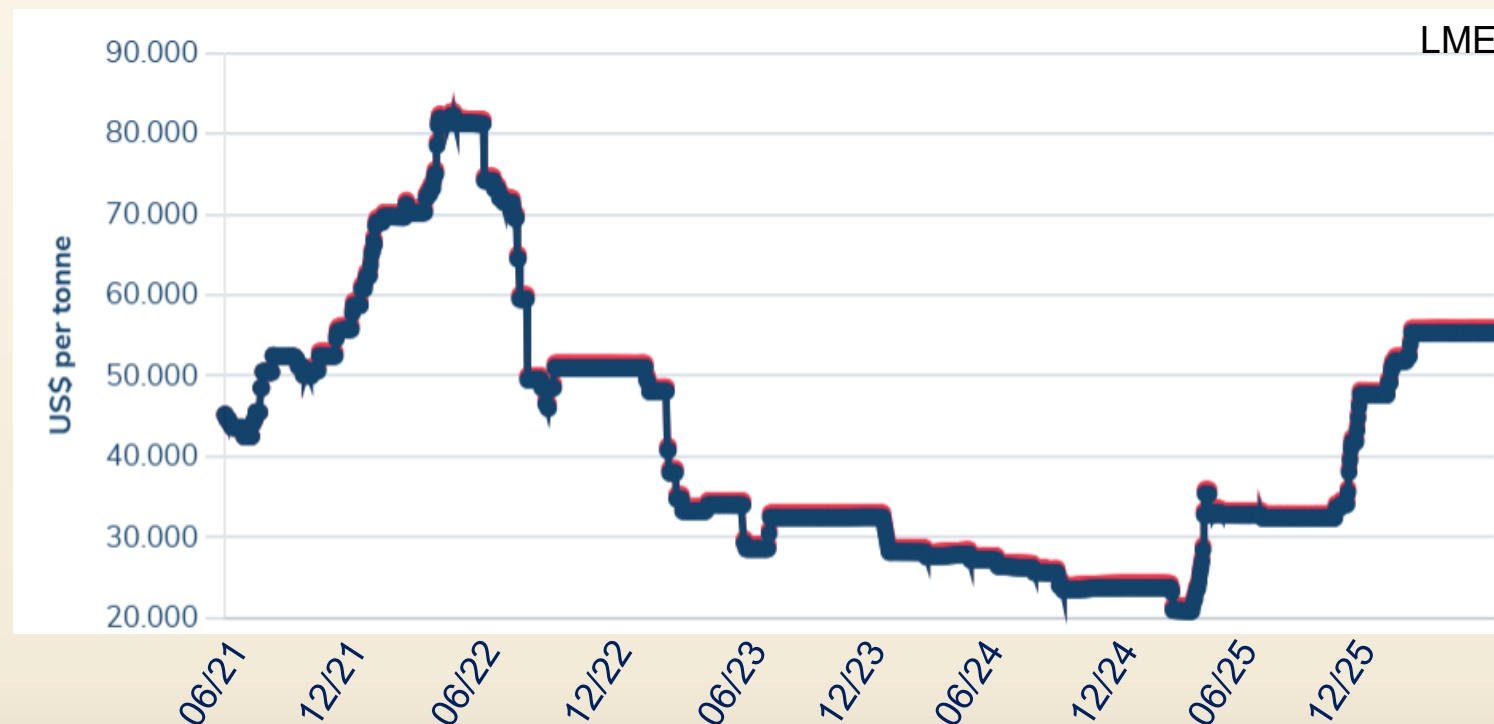
The European battery production capacity is growing, creating a major opportunity for stable and secure supply of cobalt and nickel.

Cobalt Institute

Market Context

Price swings

- Until the 2000s, cobalt prices were affected by regional political issues.
- 2000 - 2020, increased production by China.
- 2021 - 2022, mass electrification.
- 2023 - 2025, predominance of LFP batteries.
- 2025 - 2026, wars in Ukraine and Iran.



Market Context

Why Brazil?

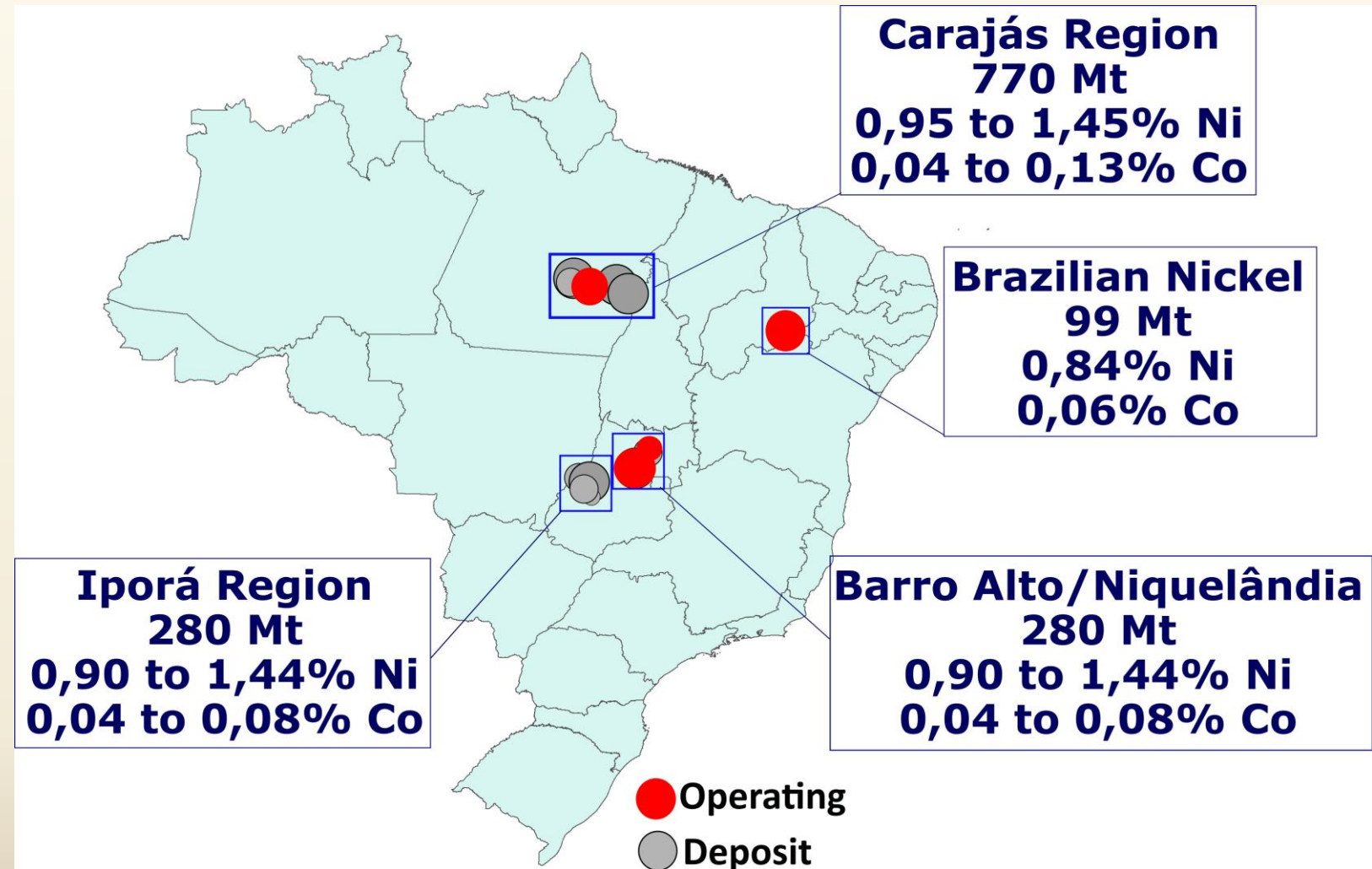
- Brazil does not have a considerable production.
- There is no prospect of cobalt production in lateritic deposits (Except for Brazilian Nickel).
- Brazil isn't exactly a big consumer of cobalt either.

PRODUÇÃO DE NÍQUEL / COBALTO	
DATA:	PREÇO EM DÓLAR:
08/10/10	NÍQUEL 23.425
	COBALTO 47.000
PRODUÇÃO REALIZADA NO DIA-NÍQUEL:	56.000
PRODUÇÃO REALIZADA NO DIA-COBALTO:	3.171
PRODUÇÃO PROGRAMADA ACUMULADA-NÍQUEL:	14.647,710
PRODUÇÃO PROGRAMADA ACUMULADA-COBALTO:	858,774
PRODUÇÃO REALIZADA ACUMULADA-NÍQUEL:	14.771.009
PRODUÇÃO REALIZADA ACUMULADA-COBALTO:	830,231
DIFERENÇA-NÍQUEL:	+123.299
DIFERENÇA-COBALTO:	-28.543

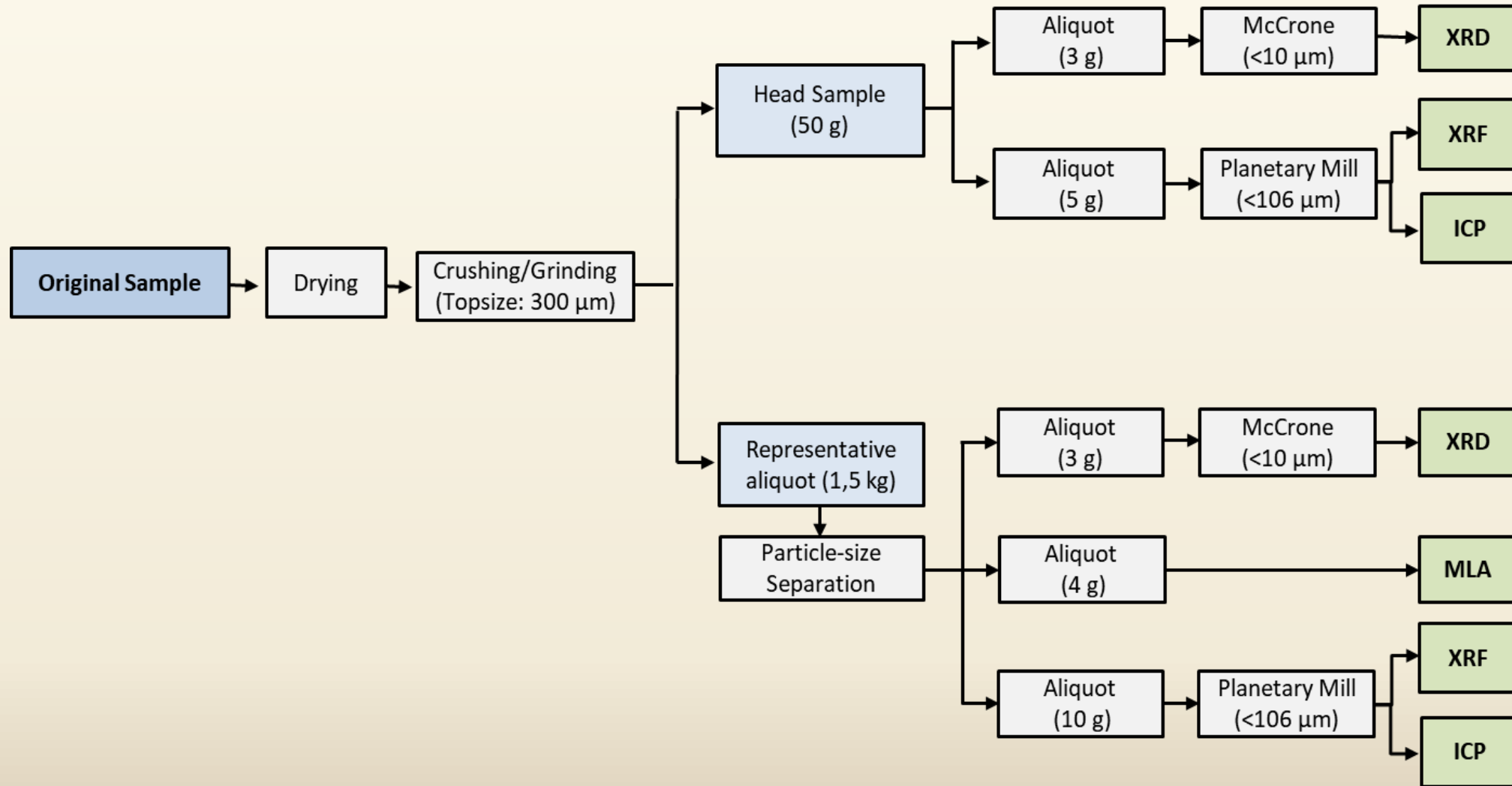
Materials and analytical methods

Why Brazil?

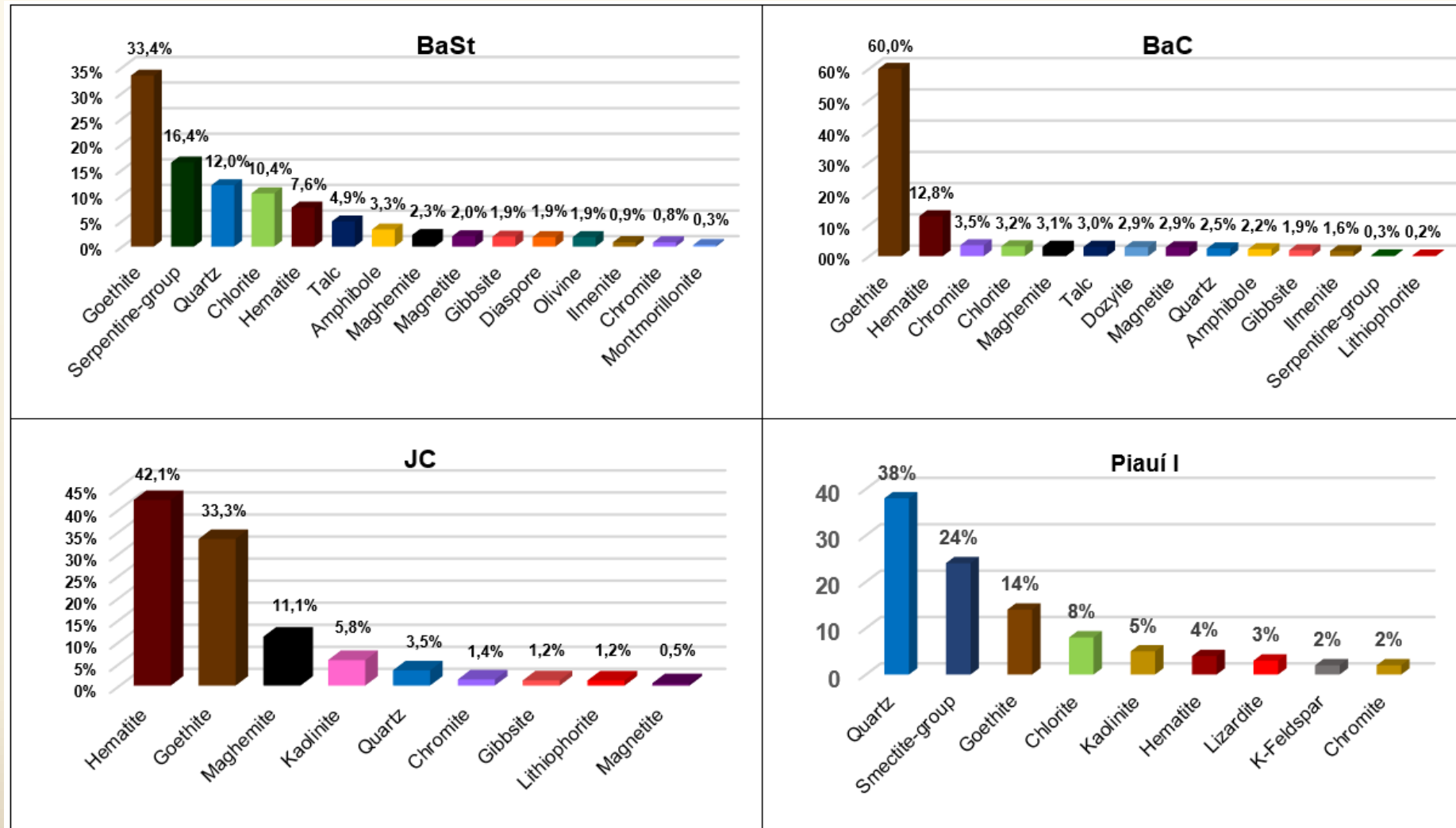
- Consolidated nickel production in lateritic deposits;
- *Friendshoring*;
- Potential for the development of new projects.

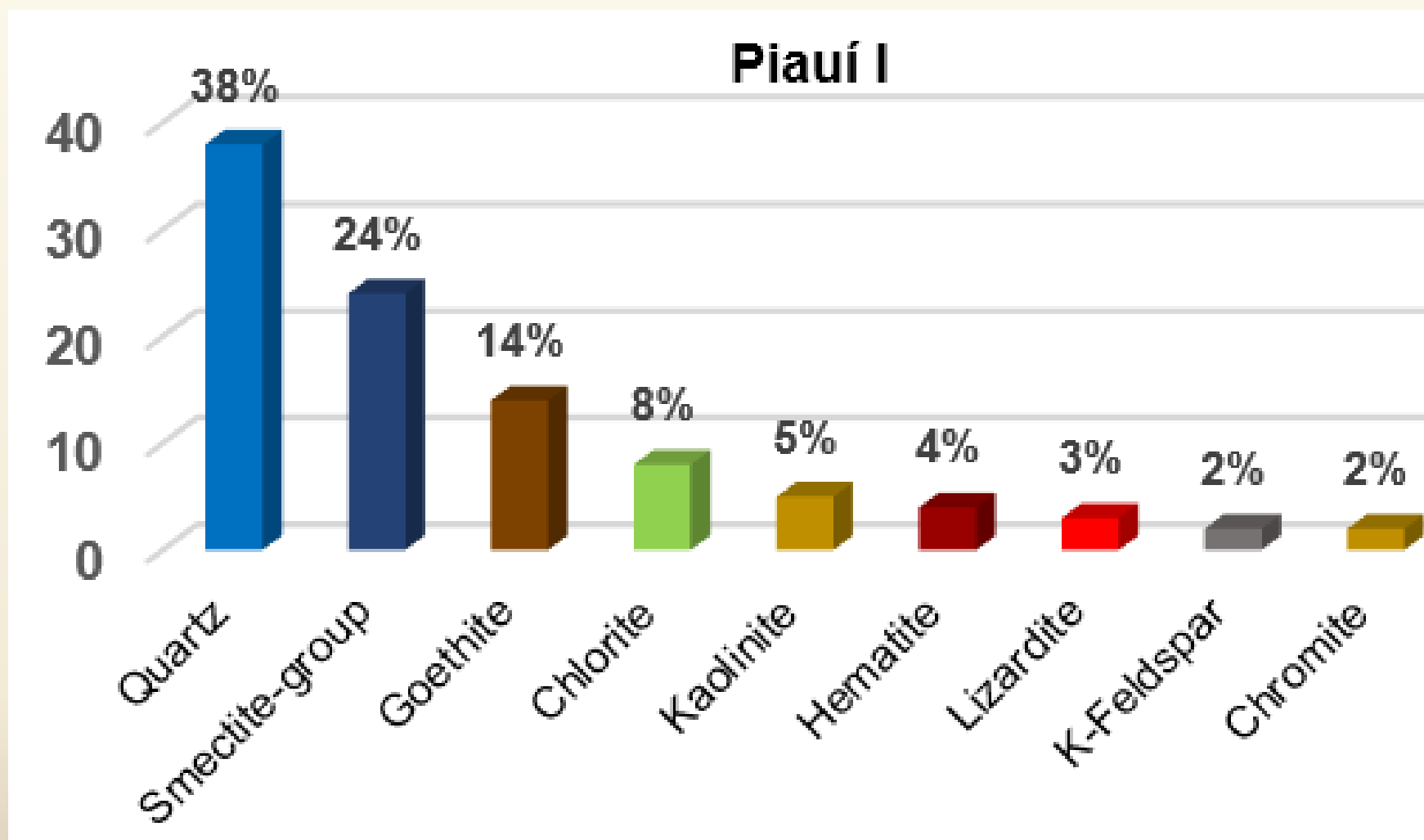


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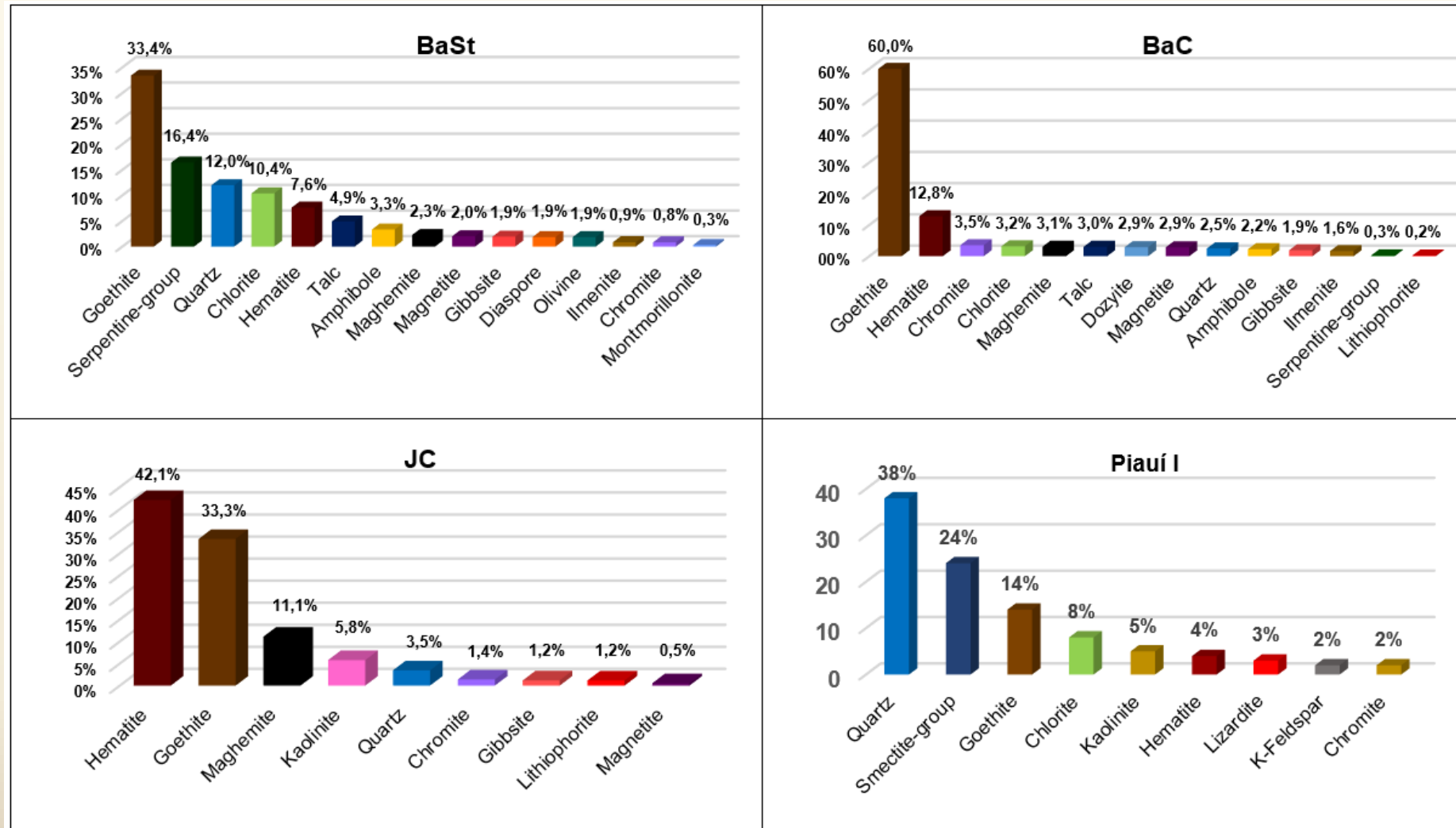


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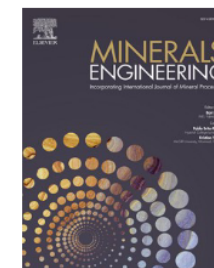


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Effect of mineralogy on Co and Ni extraction from Brazilian limonitic laterites via bioleaching and chemical leaching

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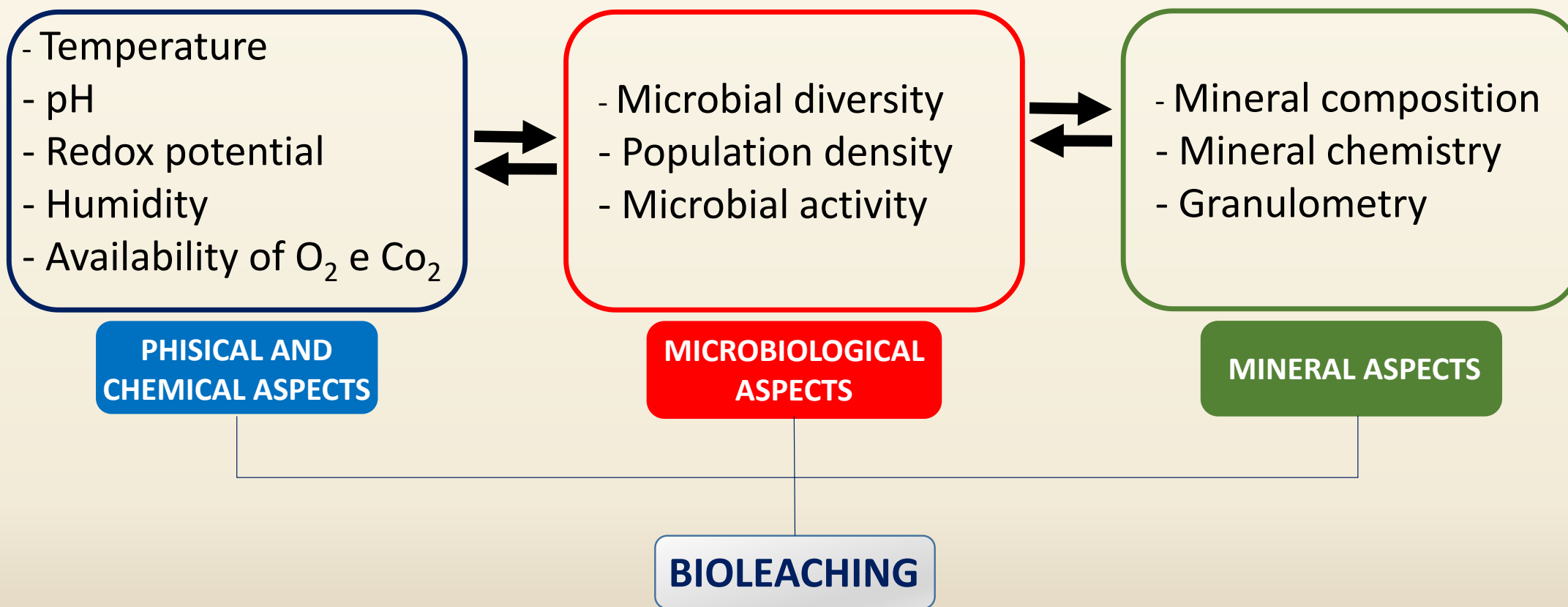
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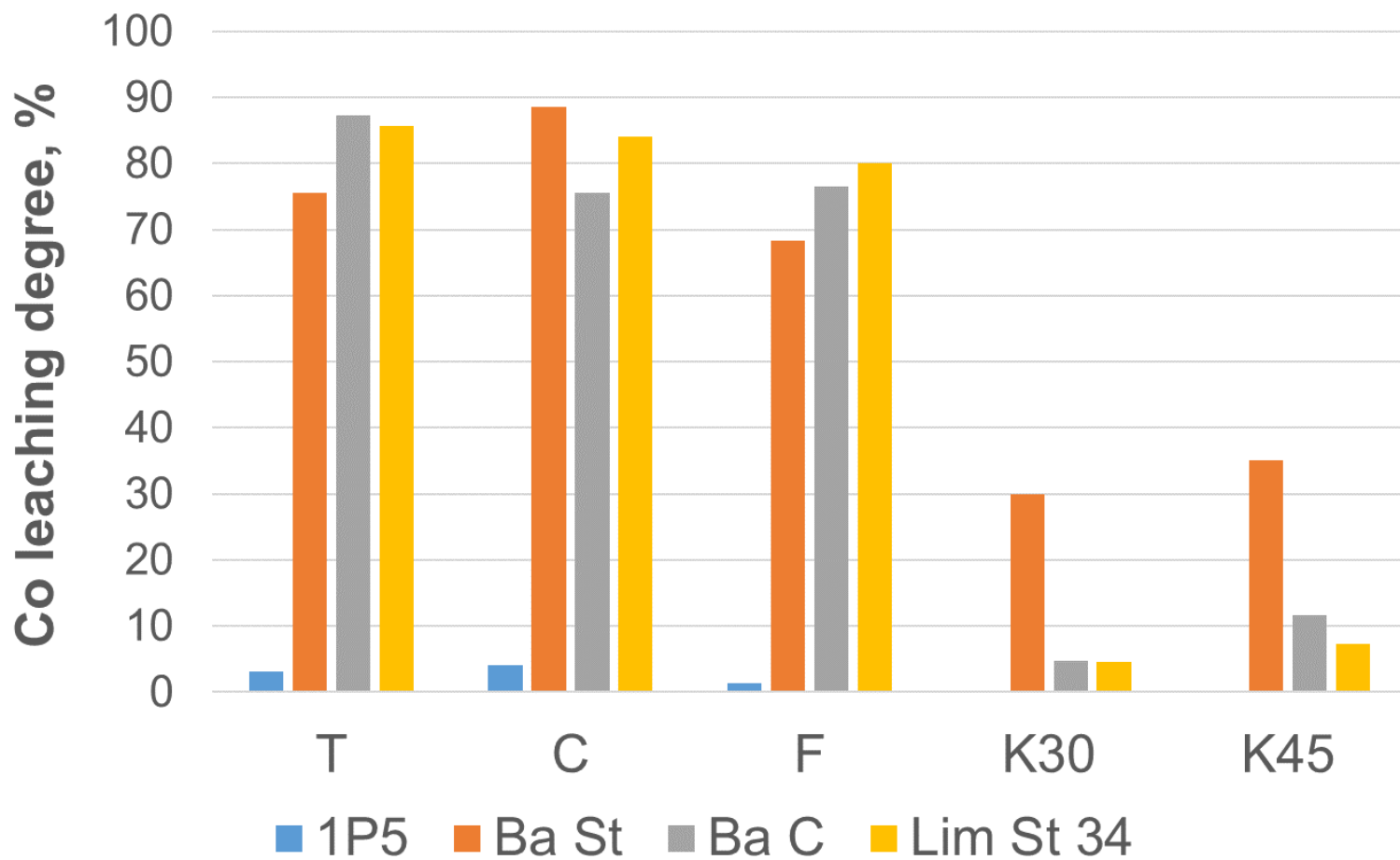


Reductive Bio-Processing

The concept of reductive bioleaching is based in the reductive dissolution of iron oxide minerals by heterotrophic acidophilic bacteria.



Reductive Bio-Processing



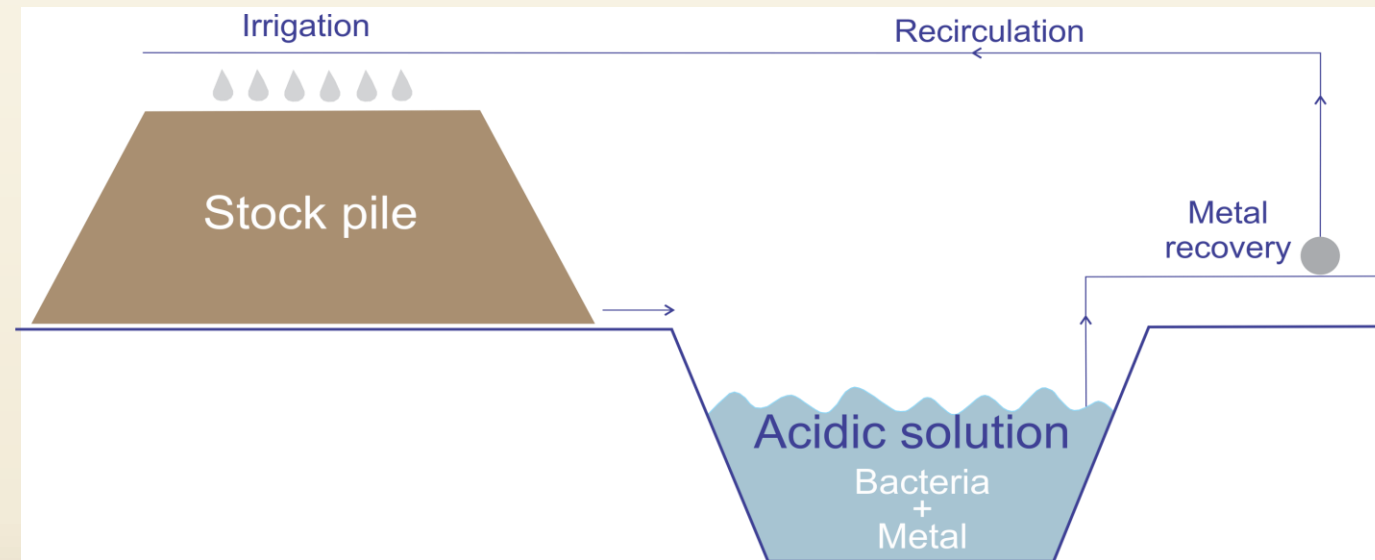
Percentage of mobilized Co at the end of bioleaching and chemical control experiments on different limonitic ores after 14 days.

T: bioreactors inoculated with *At. thiooxidans*; C: bioreactors inoculated with *At. caldus*; F: bioreactors inoculated with *At. ferrooxidans*; K30 and K45: non-inoculated controls at 30 °C and 45 °C

Reductive Bio-Processing

Experiments in 150cm percolation columns demonstrated the potential for in situ industrial application.

- Nickel: 66% recovery.
- Cobalt: 95% recovery.
- Manganese: 89% recovery.

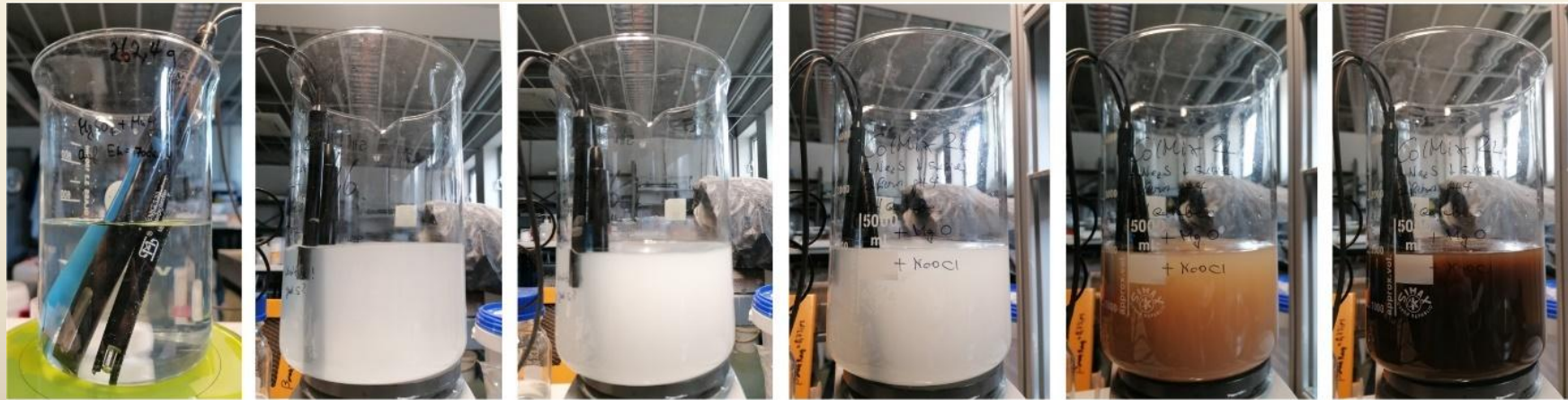


Heap bioleaching may be the most economical bioprocessing method.

Reductive Bio-Processing

Multi-step hydrometallurgical processes were developed for metal recovery from bioleaching PLS:

- Fe^{3+} and Al^{3+} removal by controlled pH precipitation using NaOH and CaCO_3 .
- Nickel and cobalto recovery via selective precipitation as mixed metal hydroxides (MHP).
- Precipitation of Fe as schwertmannite, a valuable sorbent material.
- Purification of residual MgSO_4 solutions for potential industrial use.



Economic modeling based on heap biohydroleaching processing of 1 million tons per year of lateritic ore with typical grades (1.0% Ni, 0.1% Co) shows:

- Potential gross revenue of approximately US\$128 million/year from MHP sales.
- Operating and capital expenditures estimated at ~US\$32 million/year, yielding a net profit of around US\$94 million/year before taxes.
- Significant cost savings by eliminating the need for external sulfuric acid plants and reducing lime usage.

Environmental benefits include:

- Substantial CO₂ emission reductions due to lower acid and lime consumption.
- Reduction of solid waste generation.
- Valorization of iron precipitates (schwertmannite) for environmental remediation applications.
- The bioprocessing approach aligns with sustainable development goals by promoting cleaner, more efficient extraction technologies.

Conclusions

- The BioProLat project demonstrated the feasibility of reductive bioprocessing for Ni and Co recovery, offering a sustainable alternative to conventional hydrometallurgical methods.
- Biolixiviation enables high metal recoveries with reduced chemical consumption and environmental impact.
- The industrial implementation of bioleaching in heaps may be technically and economically feasible, with ongoing research focused on scaling up, optimizing recovery rates, and integrating subsequent metal recovery processes. Longer processing times (days to weeks) compared to conventional methods are a major limitation.
- The Brazilian nickel-cobalt laterite deposits represent a strategic resource for both domestic and international markets.

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Thanks

