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Instituto de Ciências da Terra
Institute of Earth Sciences

The potential of reprocessing Au and by-products from a tailing dam in the Iron Quadrangle - The case of the Cuiaba Dam, Sabará, Minas Gerais

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Morgantown, West Virginia, USA
April 21–26, 2024



Problems with tailings dams

- Structural Weakness
 - Due to poor construction or maintenance, dams can be vulnerable to failure, leading to catastrophic consequences
- Environmental Pollution
 - Leakage or rupture of tailing dams can result in the release of toxic substances into water bodies, soil, and air, causing severe environmental damage
- Human Impact
 - Tailing dam failures pose significant risks to nearby communities, including loss of lives, displacement, and long-term health effects



Problems with tailings dams

Mariana dam disaster - 2015



<https://opopular.com.br/cidades/corpo-de-mais-uma-vitima-de-tragedia-de-mariana-e-encontrado-quatro-meses-depois-1.1049514>

Brumadinho dam disaster - 2019



<https://oglobo.globo.com/brasil/noticia/2024/01/25/desastre-em-brumadinho-veja-o-antes-e-depois-da-regiao-afetada-pelo-rompimento-da-barragem-da-vale.ghtml>

Circular economy in the Mining sector



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Source: <https://eitrawmaterials.eu>

SUSTAINABLE DEVELOPMENT GOALS



Objectives

- Characterize Au Mine Tailings
- Evaluate waste reuse potential
- Recovery of Au from tailings
- Assess the potential for producing fine aggregate for the construction industry

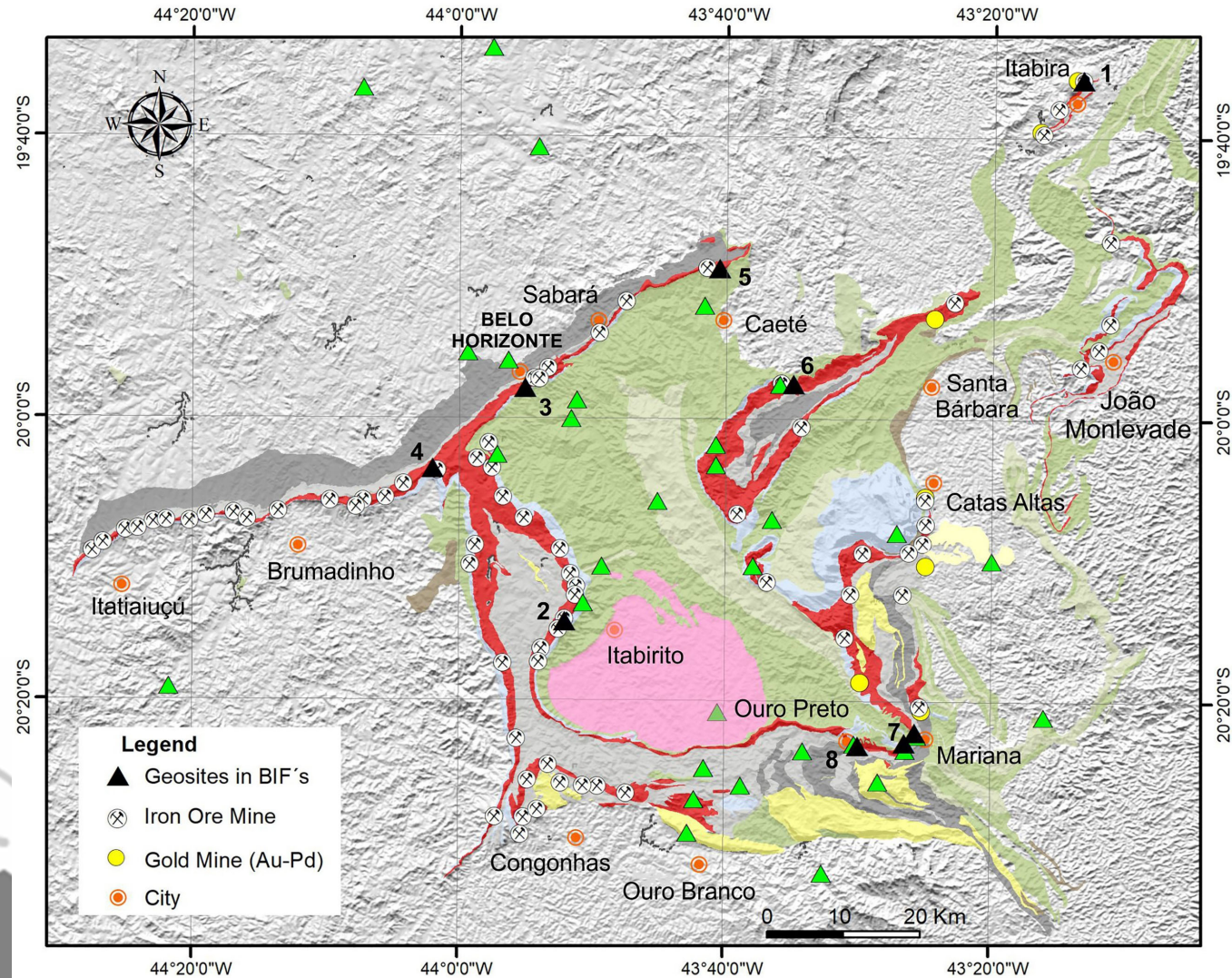


Study Area



- Iron Quadrangle

- Metallogenetic province that hosts large deposits of Au and Fe, as well as gems and industrial minerals

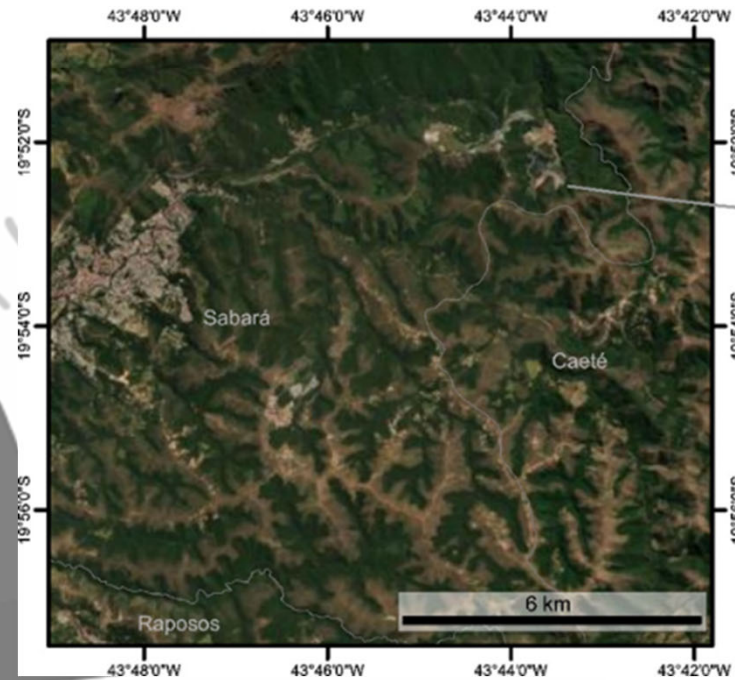
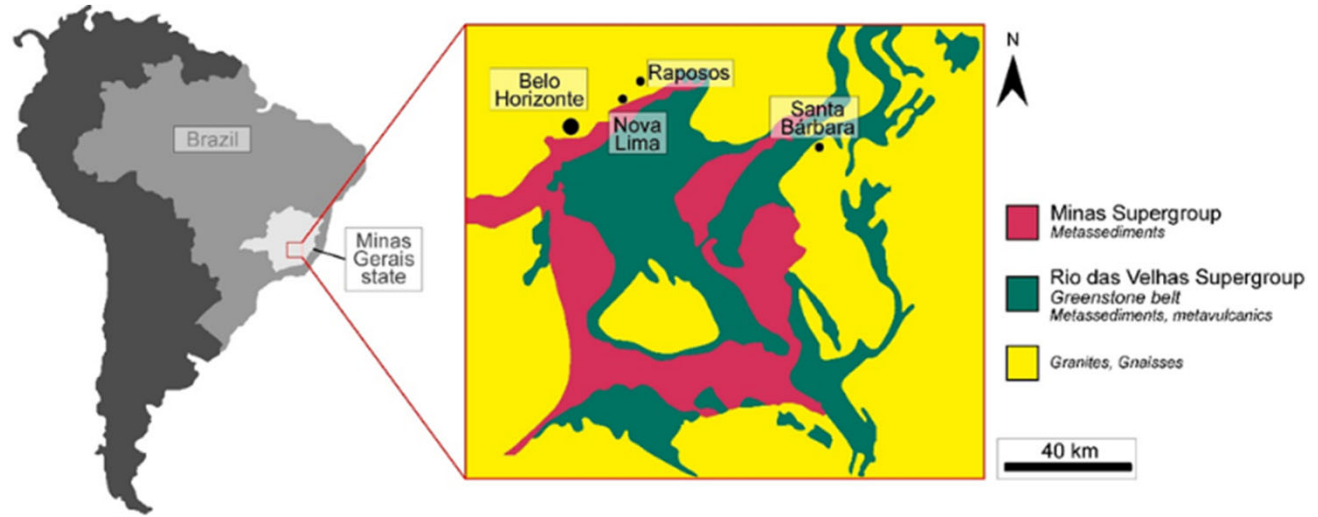


Fonseca Formation	Minas Supergroup	Rio das Velhas Supergroup	Granite-Gneiss Complex
Estrada Real Supergroup	Piracicaba Group	Nova Lima Group	Bação Complex
Itacolomi Group	Itabira Group	Maquiné Group	Others Geosites
Sabará Group	Caraça Group	Quebra Osso Group	

Study Area

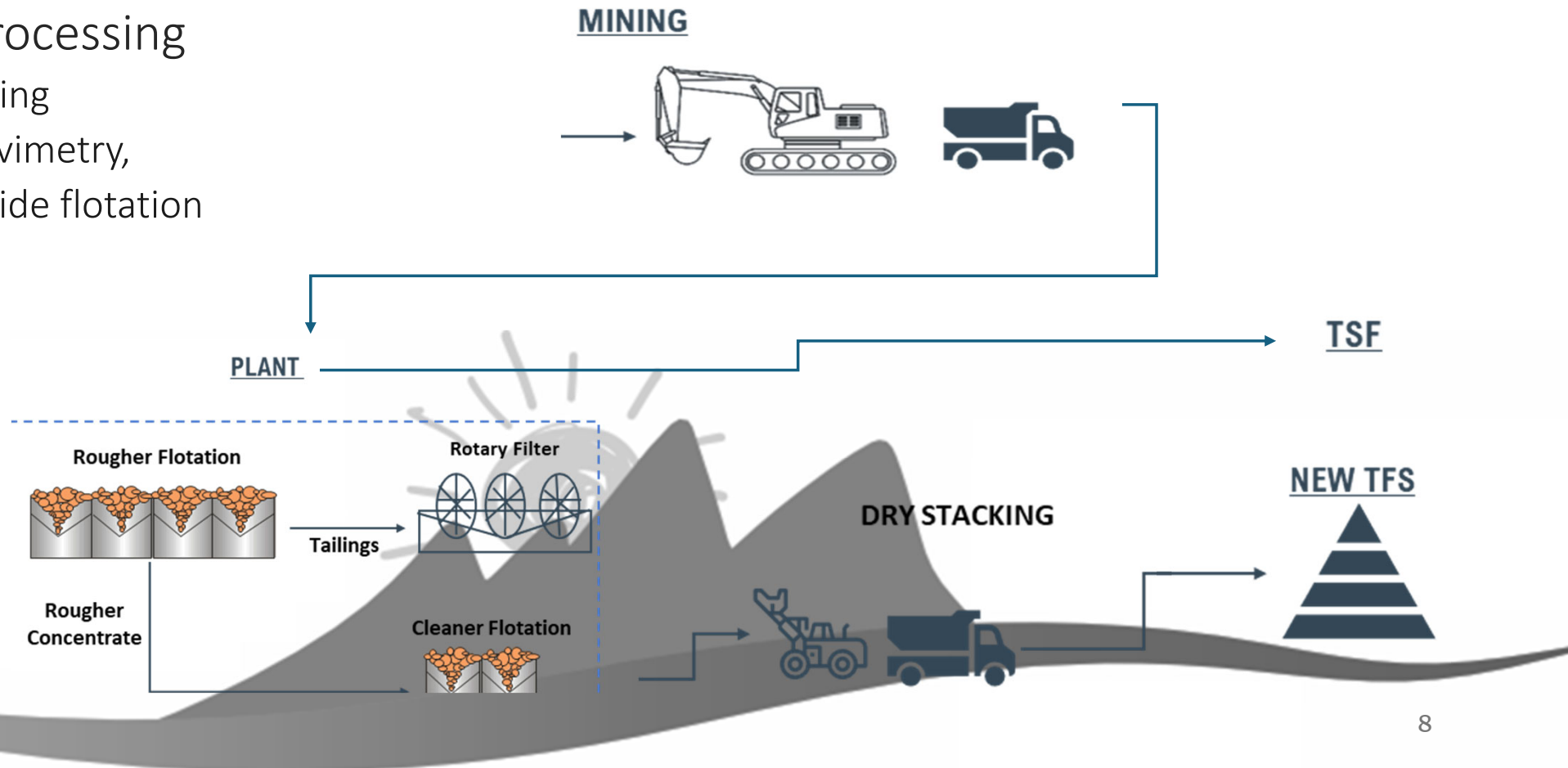
- Iron Quadrangle
 - Gold deposits in Archean and Paleoproterozoic rocks

- Sabará region
 - Cuiaba TSF

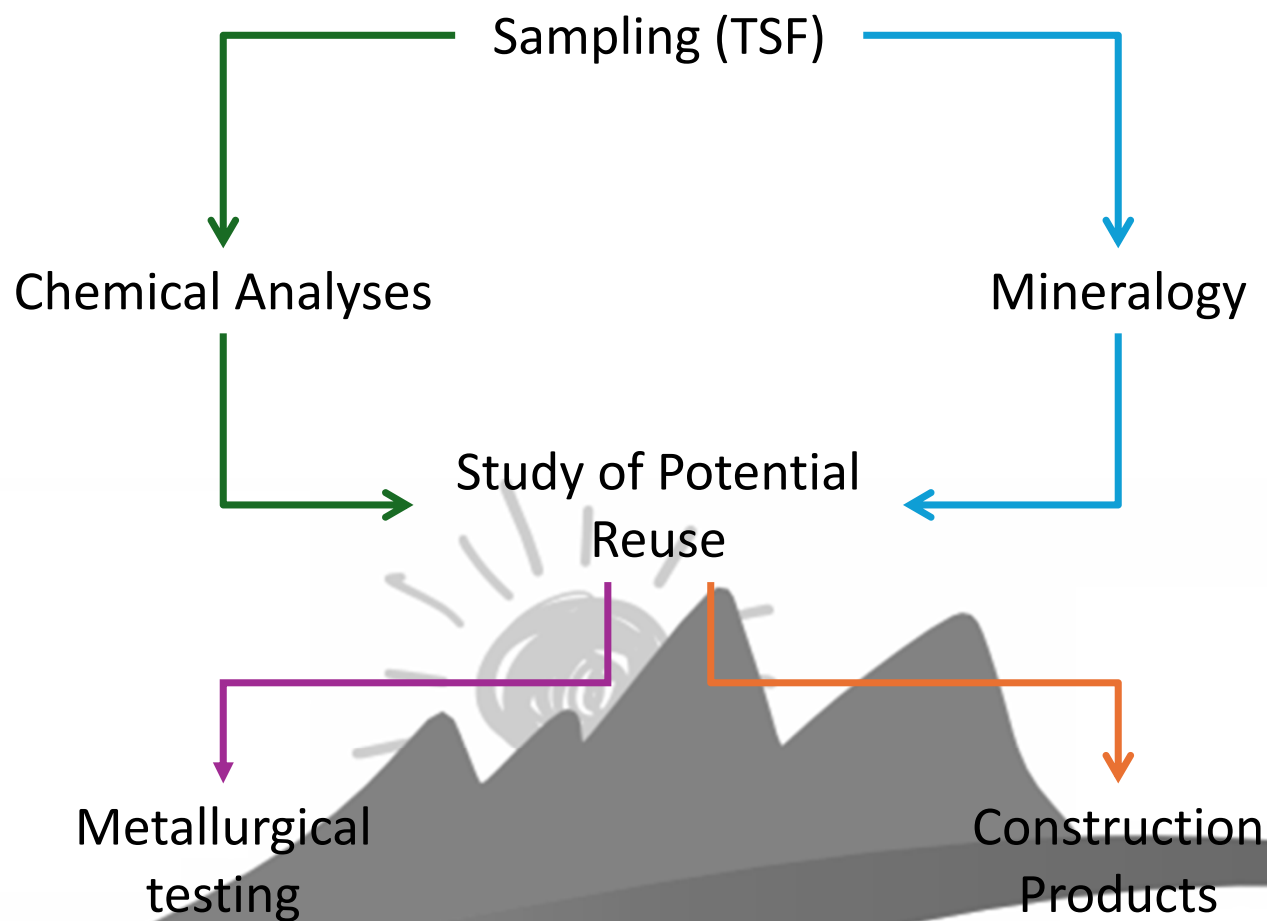


Study Area

- Ore processing
 - Milling
 - Gravimetry,
 - Sulfide flotation



Methodology



Methodology

Sampling

- The event is held in winter and early spring (May to September 2020)
- Sampling of the tailings piles up to a maximum of 20 m, totaling 2342 m sampled
- the distance between boreholes ranged from 10 to 50 m

Chemistry

- ICP
- Fire assay
- AAS
- Infra-red
- PSD by laser

Mineralogy

- OM
- XRD
- SEM
- MLA

Au Recovery

- Grinding 74 μm
- Cyanide leaching

Aggregates

- fractions above 20 μm
- replacement of sand in the generation of grout in the proportions 25%, 50%, 75%, and 100%
- 28 days of the curing period;
- flash kiln at temperatures until 1000 °C
- Product tested as agglomerate in substitution of cement in proportions 25% and 50%
- 28 days of curing period.

Results

- General properties of the tailings

- Chemistry

Elements		
Si		22.1
Fe		12.3
Ca		5.21
Al		3.49
C		3.43
S	%	2.49
Mg		2.02
K		0.750
Mn		0.570
Na		0.460
Ti		0.320
As		0.150
Au	mg/kg	0.200

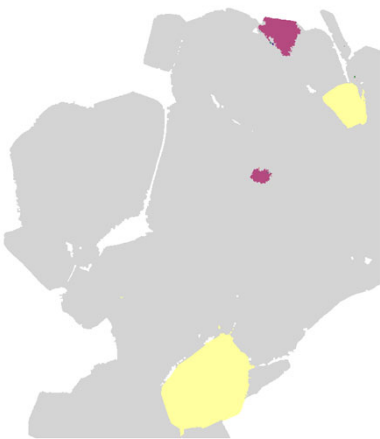
- Mineralogy

Minerals	Chemical Formula	Wt%
Quartz	SiO ₂	37.98
Feldspar Group		
Albite	NaAlSi ₃ O ₈	4.43
Sheet Silicates		
Muscovite Group	KAl ₃ Si ₃ O ₁₀ (OH) _{1.9} F _{0.1}	8.92
Chlorite	(Mg,Fe) ₃ (Si,Al) ₄ O ₁₀ (OH) ₂ (Mg,Fe) ₃ (OH) ₆	15.8
Carbonates		
Ankerite	Ca(Fe,Mg,Mn)(CO ₃)O ₂	6.95
Siderite	FeCO ₃	
Calcite	CaCO ₃	
Sulfides		
Pyrite	Fe ²⁺ S ₂	
Pyrrhotite	Fe ^{2+0.95} S	0.71
Arsenopyrite	Fe ³⁺ AsS	
Au phases*	Native Au and electrum	252*

Results

- Au recovery
 - Leaching tests

P80 μm	Au mg/kg	CN mg/kg	CaO mg/kg	AuRec %
74	0.20	2000	4000	40



False electronic image of Au
(yellow) enclosed in quartz

Results

- Generation of construction products
 - In natura – Toxicity and reactivity tests



	Leaching Extract Results (mg/L)	VMP mg/L
Mn	0.12-0.14	-
SO ₄ ²⁻	634.4-1236	≈5000

Tailings are classified as Class IIA
(non-hazardous and non-inert)

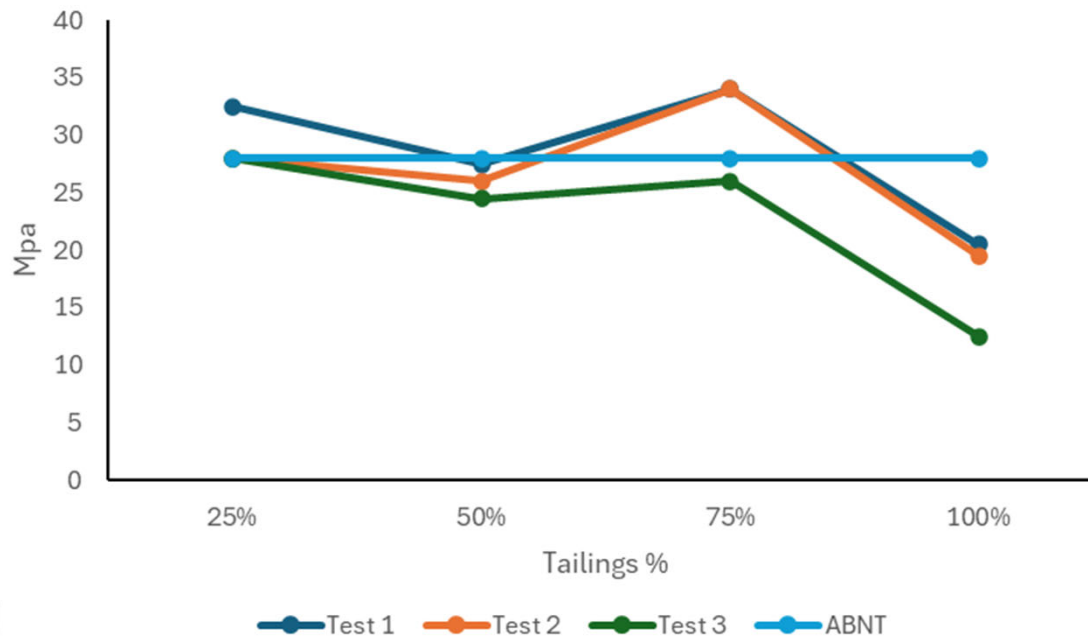
Standards:

ABNT NBR 1004:2004

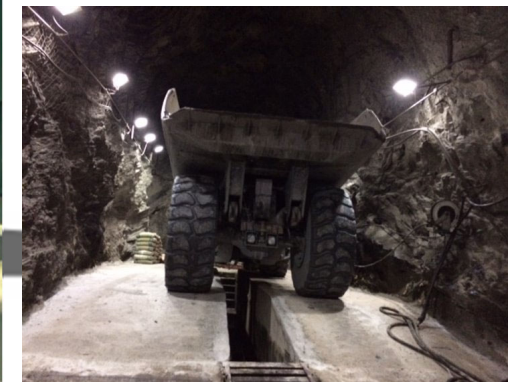
NBR 7211:2005

Results

- Generation of construction products
 - In natura
 - Mortar strength tests

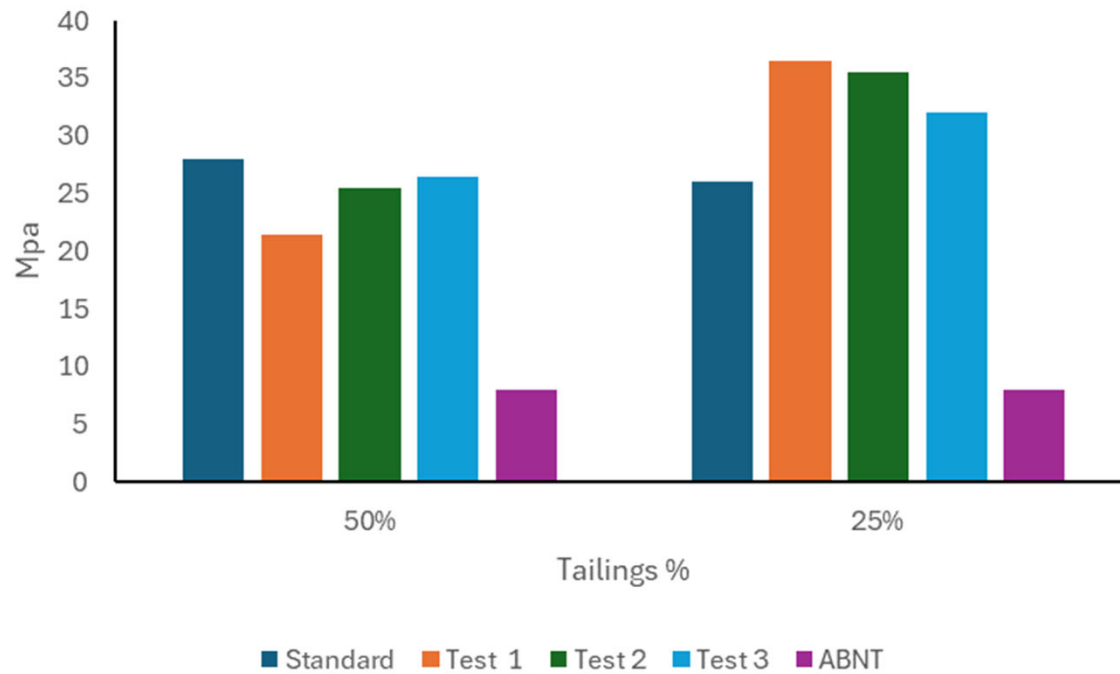


- Construction application examples



Results

- Generation of construction products
 - Calcinated – PAI



Results

- Generation of construction products
 - Calcinated
 - Index PAI (Pozzolan Activity Index)

Waste A



Normal

Calcinated

Waste B



Normal

Calcinated

Waste C



Normal

Calcinated

Conclusion

- Even with low recoveries of the Au element, alternative and optimization routes can be better evaluated in conjunction with the total reuse stages;
- Products such as fine aggregates and binders were successfully generated and opened avenues for recovery and use in infrastructure works in the region.

Recovering this waste proves to be an important step for society and the environment, demonstrating that mining activity and society can live in balance



7th to 11th of July
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Organization



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Technical support





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