PLANNING for closure 2024

5th International Congress on Planning for Mine Closure

Tailings Storage Facilities Closure: threats and challenges

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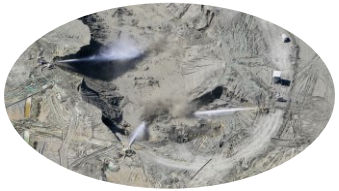
GECAMIN


Tailings dams is one of the first postcard of Chile for foreign visitors

"*What is to become of our increasingly large Tailings Storage Facilities? The largest mines increase in magnitude every 30 years, with the quantities of tailings also growing in proportion. Single dams are now occupying many square kilometers, growing higher, and becoming* ***giants of the landscape*** *...Tailings dams are long term hazards, and* ***must remain stable in the landscape long after we are no longer there to monitor them*** *"*

Andy Robertson†

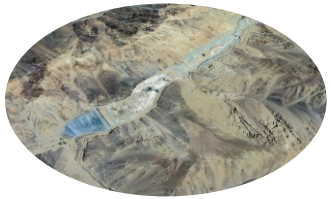
“Cannibalism” as a closure option



Cauquenes

Colihue

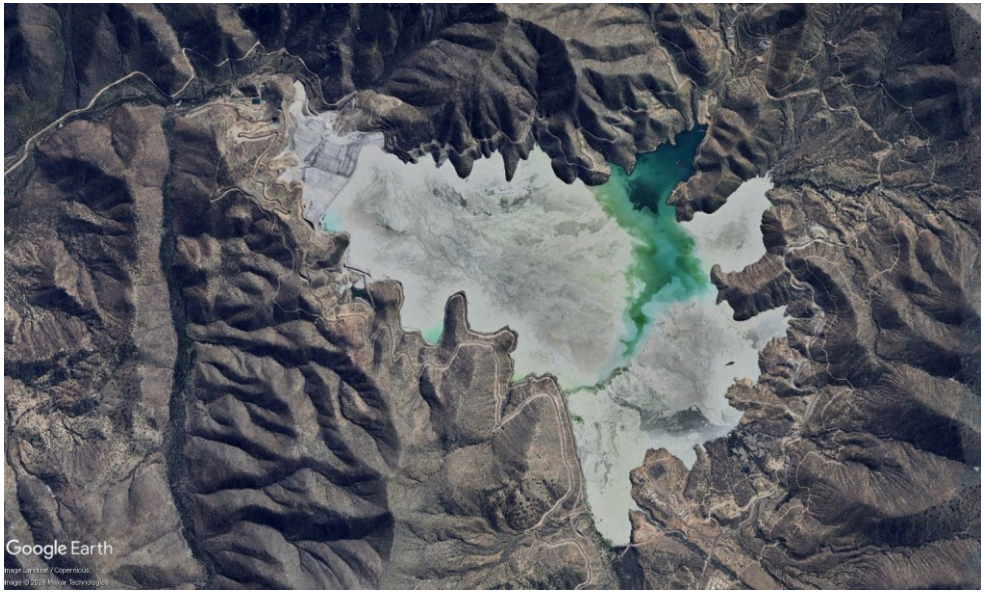
Embalse Caren



Pérez Caldera

Tranque las Tórtolas

?



Why couldn't we magically make the tailings disappear?

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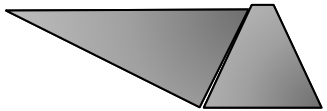
Maybe reprocessing and recovering value is the option?

Economics of mine tailings:
270 Mt @ 0.15% Cu with 12 km^2 surface



405,000 t Cu @ 9,664 US$/t = **3,833 MUS$**
250 Mt sand @ 8 US$/t = **2,000 MUS$**
Saved remediation costs:
1,200 ha @ 500,000 US$/ha = **600 MUS$**

(*After Dodld D., 2020*)

How could we recover 100% of the copper?
What would be the reprocessing costs?
How do we transport such amount of sand?
Is zero waste a realistic option?

50,000,000 t/year

Transforming 10% into a commercial product:

5,000,000 t/year

13,700 t/day

30 t capacity trucks:

457 trucks/day

19 trucks/hour

Is that sustainable ?

So, what are the closure options?

What are the main challenges?

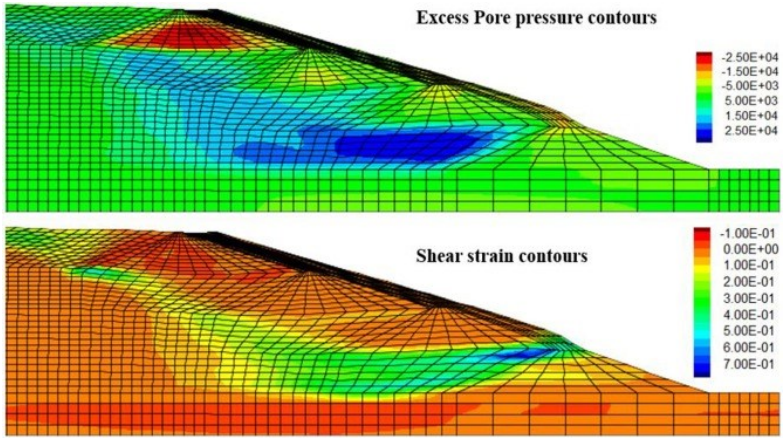
Chemical vs. physical stability

- Physical stability of TSF has historically concentrated major attention from both regulators and operators.
- Chemical stability and potential impacts associated with mine drainages and infiltrations is gaining a growing attention.

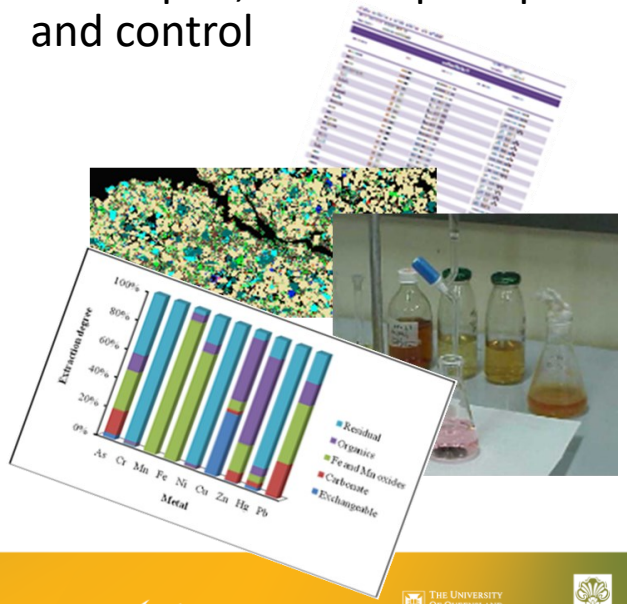
Chemical vs. physical stability

Prediction, prevention and control

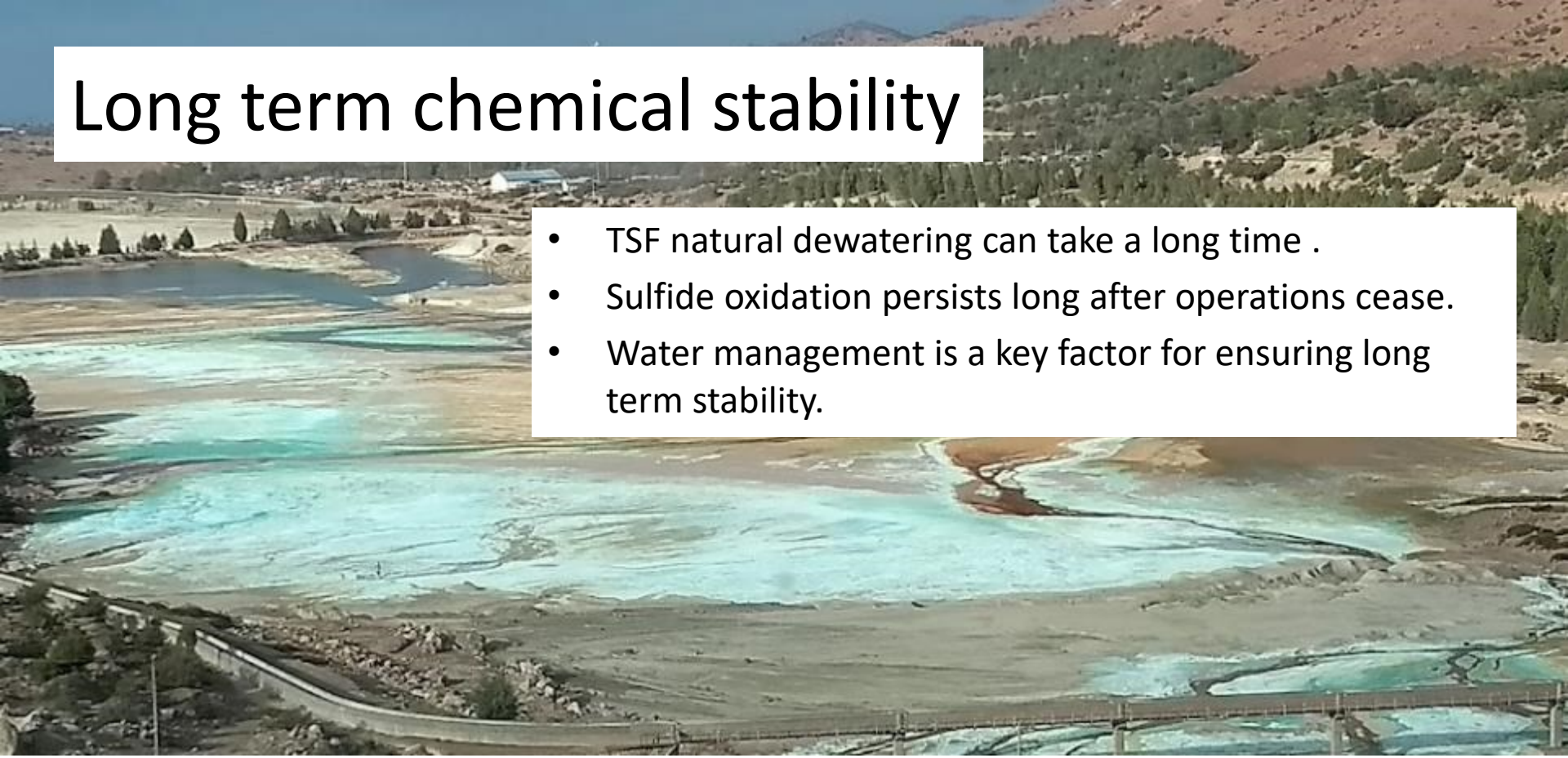
- Physical stability: well established



- Chemical stability: prediction well developed, but still poor prevention and control



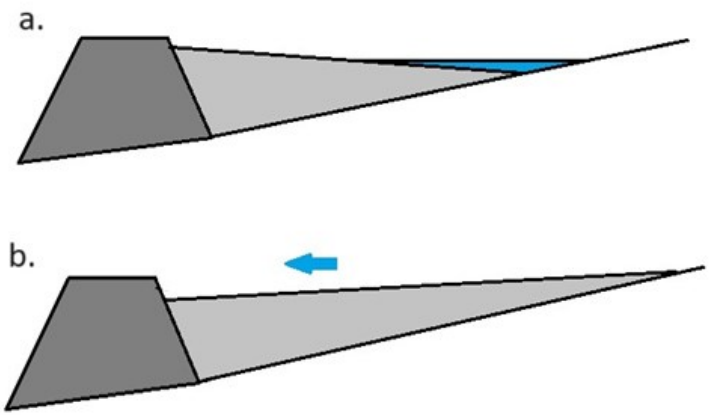
Long term chemical stability



- TSF natural dewatering can take a long time .
- Sulfide oxidation persists long after operations cease.
- Water management is a key factor for ensuring long term stability.

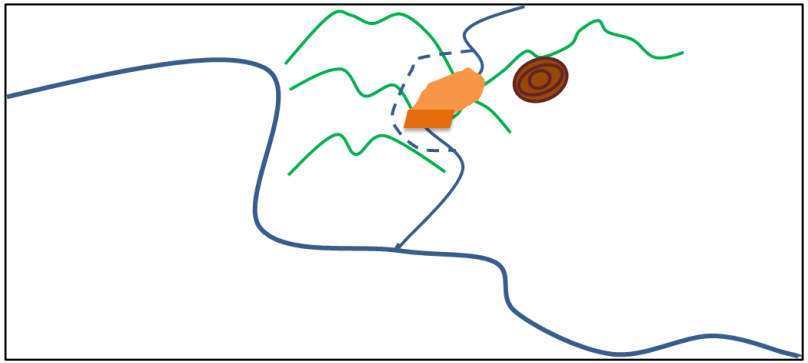
Chemical vs. physical stability

- Reconciling chemical and physical stability can be challenging.
- For physical stability requirements, water management aims to prevent the water pond from coming in contact with the dam
- However, from a chemical stability perspective, water storage in the dam should be minimized.

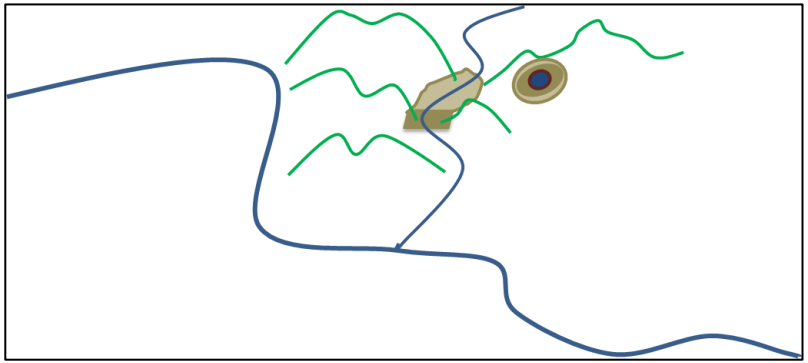


- The recommendation would be to promote runoff and establish a slope form the back to the dam (b), which might increase physical stability risks.

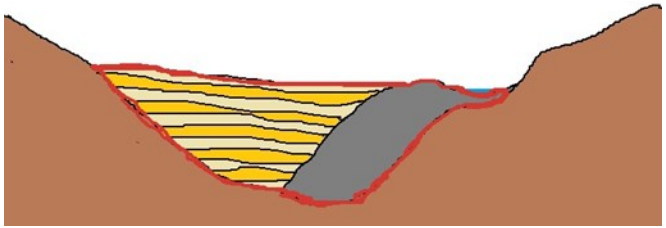
During operation



After closure



- Rocks for the river Chanel
- Processed tailings
- Mine waste rocks
- Paste rock



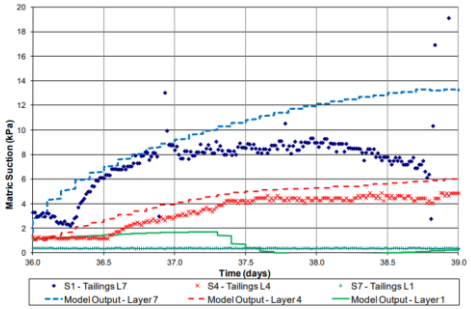
Economic and environmental sustainability

Mining project	TSF closure costs (in US$ equivalent)	% of the total closure costs
Escondida (BHP)	$552,543,646	31%
Chuquicamata (Codelco)	$227.731.158	23%
Collahuasi (Anglo/Glencore/Mitsui)	$37.902.942	9%
Quebrada Blanca (Teck)	$19.977.565	8%
Pelambres (AMSA)	$30.772.242	7%
Andina (Codelco)	$892.283.816	44%
El Teniente (Codelco)	$491.324.950	39%

- The estimated TSF closure cost is highly variable.
- All assessed mine closure plans incorporate a cover for the TSF.
- None of the projects identify the sources of the granular material and topsoil.
- Potential impacts associated to the extraction and transport of these cover materials have not been considered

Closure plan validation

- Typically, proposed closure solutions are designed based on models.
- The determination of the required cover thickness for an effective low-permeability or a store-release cover system should be validated through extended on-site pilot tests.



Fuente Inproyen,
Gold Fields La Cima S.A. – Perú

- There is a need for increased emphasis on devising a validation strategy for closure plans.
- The efficiency of closure measures will always depend on the specificities of the site and the characteristics of the materials available in the area.
- The validation process should start early in the operational phase, with the results of pilot tests informing ongoing improvements, optimizations, and updates to the closure plan.

Design for closure

- **Topic III: Design, Construction, Operation and Monitoring – Requirement 5,6:** the closure phase of TSF should be designed "in a manner that meets all the requirements of the Standard, with sufficient detail ***to demonstrate the feasibility of the closure scenario*** and to allow implementation of elements of the design during construction and operation as appropriate. The design should include ***progressive closure and reclamation during operations***"

The future uses of territory

- Revegetation is often the initial choice but may not prove to be a sustainable option in arid climate.
- Reestablishing a surface similar to the one existing prior to the construction of the deposit.
- Conversion of the closed TSF for other productive activities, such as a solar energy field.
- All these options should be considered from the design stage of the project and developed with the active participation and involvement of the local communities and stakeholders.

Thank you

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