FUNDACIÓN CHILE

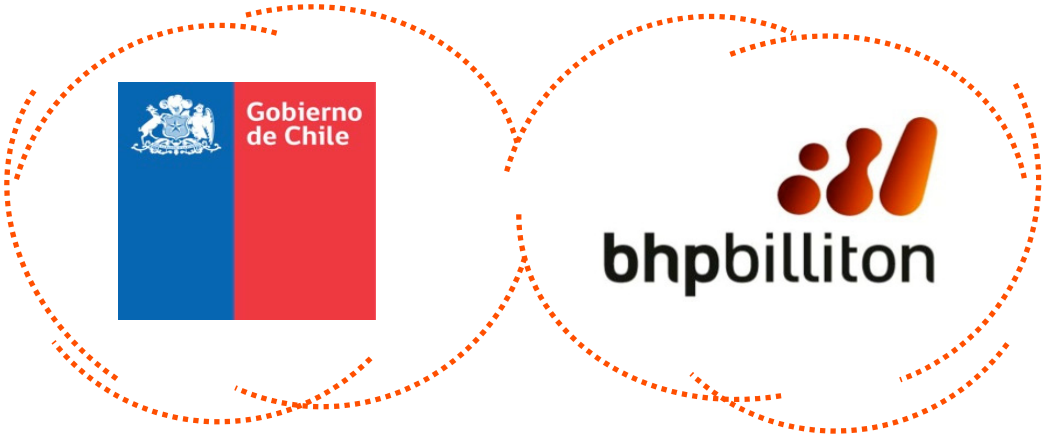
21th Annual British Columbia-MEND ML/ARD Workshop

The challenge of chemical stability in Chile: the current scenario and practical applications

María Carolina Soto
Environmental Risk Management Project Manager
Sustainability Area

Date: 04/12/2014

Fundación Chile: Our Mission



Public – Private Alliance

To promote the incorporation of **TECHNOLOGIC INNOVATION** in productive entrepreneurship articulating the **ECOSYSTEM** of national innovation

Proyecto apoyado por CORFO

We are + de 400 professionals

FUNDACIÓN CHILE

What do we do?

FUNDACIÓN CHILE

SUSTAINABILITY

FOOD AND BIOTECHNOLOGY

HUMAN CAPITAL

ENTREPENEURSHIP PLATFORM

Creation of direct value

Enabling Projects

Transfer Services

Proyecto apoyado por CORFO

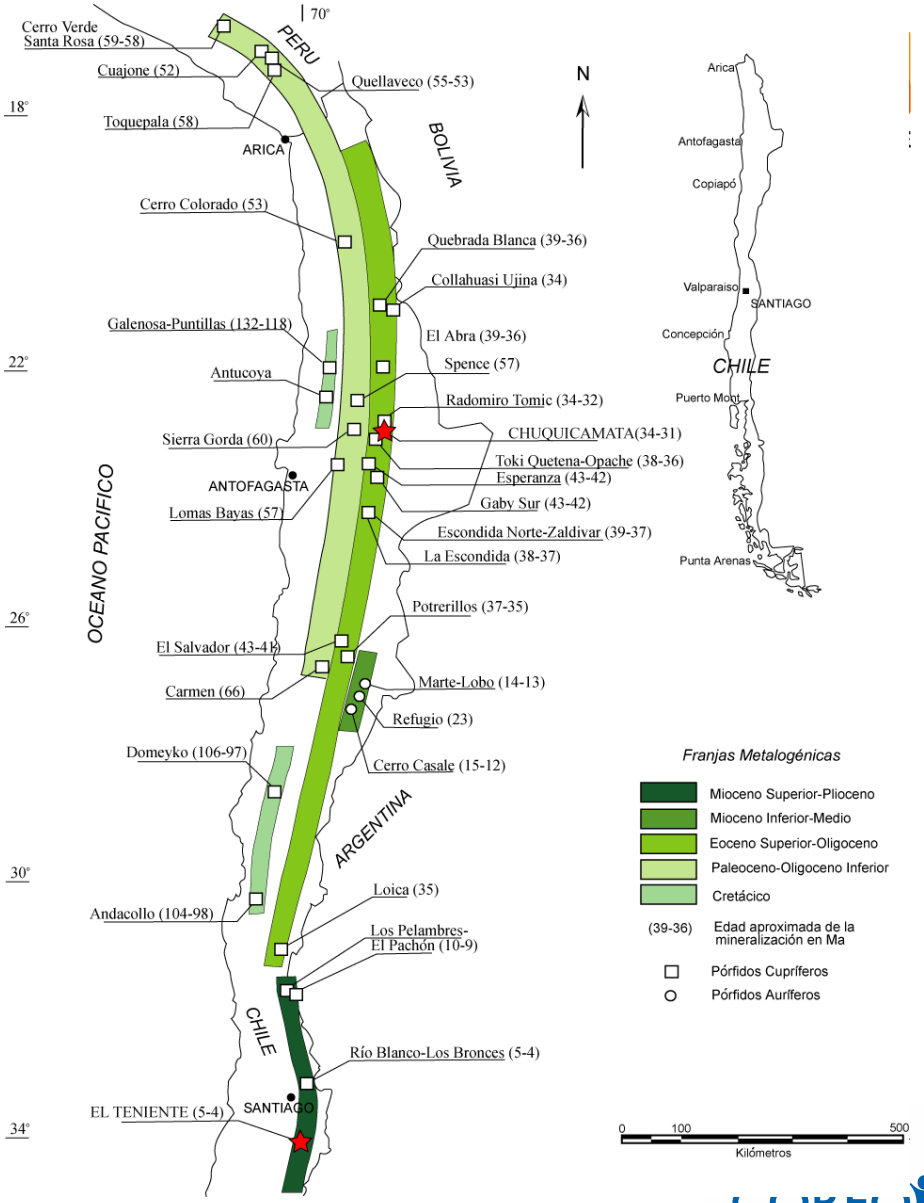
Chile, mining country

Geological Context

About 40% of the known copper resources of the world occur in Chile.

Types of deposits include: **porphyry Cu-Mo deposits, epithermal precious metals, IOCG (iron oxide copper-gold and iron oxide-apatite), stratabound copper-(silver) ores, precious metal veins, sedimentary-hosted gold and porphyry gold deposits and skarns.**

Some of the world's largest and richest porphyry Cu-Mo deposits occur in the Andes of northern Chile

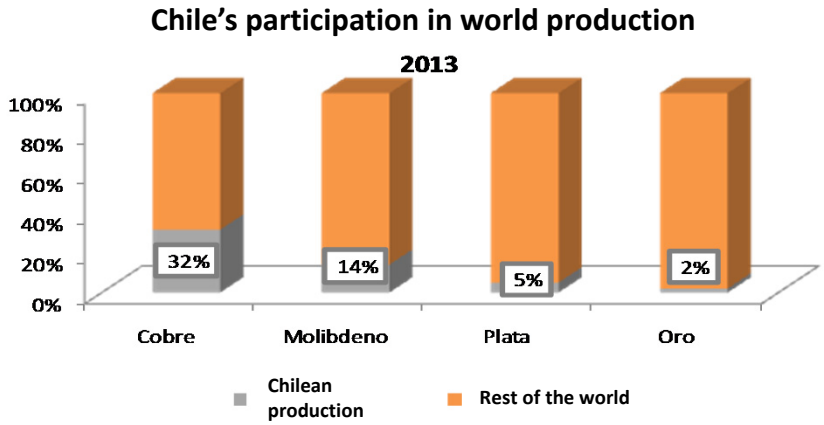


Chile, mining country

FUNDACIÓN CHILE

Chile, mining country

FUNDACIÓN CHILE



- ✓ 1° in copper production
- ✓ 3° in molibdenum production
- ✓ 7° in silver production
- ✓ 14° in gold production

15 companies

95% of national copper production

AngloAmerican · BARRICK · bhpbilliton resourcing the future · bhpbilliton Pampa Norte · CODELCO Orgullo de Todos · COLLAHUASI · El Abra · Freeport-McMoRan Copper & Gold · GLENCORE · KINROSS · Los Pelambres Antofagasta Minerals · LUMINA Copper Chile · Candelaria · Minera Escondida Operada por BHP Billiton · Teck · YAMANAGOLD

The Current Scenario

Mining companies have to attend and operate considering legislation and local, national and international expectation

Among them:

2008 Chile ratifies Convention No. 169 of ILO

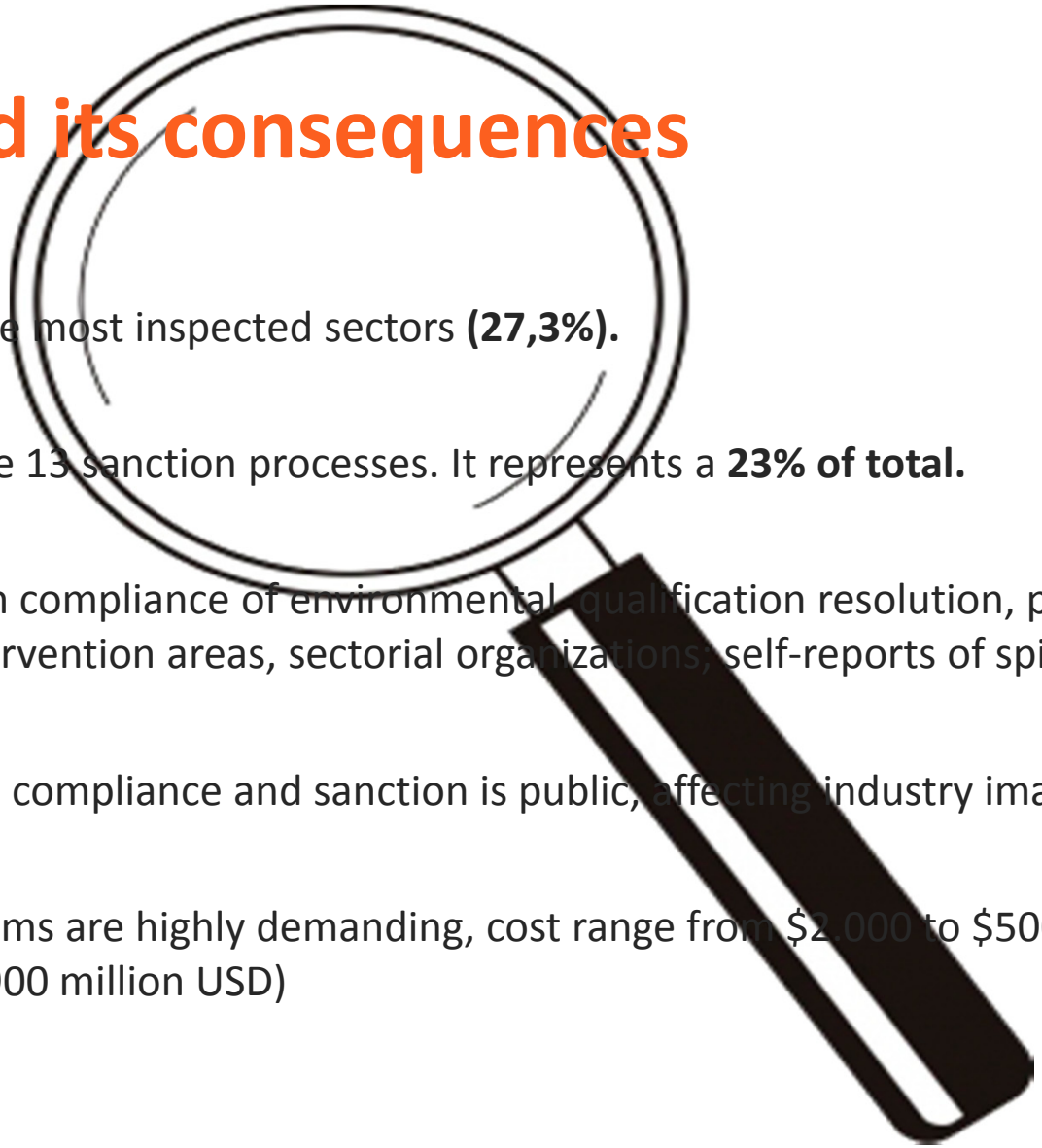
- Mechanism that seeks to ensure that indigenous and tribal communities are consulted and involved in the decision making process of what happens on their land.

2010 · Environmental Superintendence

2012 · Mine and Mining Facilities Closure Law

Proyecto apoyado por CORFO

Audits and its consequences



- Mining is one of the most inspected sectors **(27,3%).**
- Currently there are 13 sanction processes. It represents a **23% of total.**
- Complaints by: non compliance of environmental qualification resolution, permits, archaeological intervention areas, sectorial organizations, self-reports of spills.
- Information of non compliance and sanction is public, affecting industry image
- Compliance Programs are highly demanding, cost range from $2.000 to $500.000 millions CLP (3 to 900 million USD)

Proyecto apoyado por CORFO

Litigation of projects

- There are more than **211 active conflicts by mega-mining***
- **Chile** and Perú topped the list with **35***
- In Chile in 2013, **21 of the 47 planned mining projects were postponed**, which is equivalent in terms of investment at approx. **US $ 63.019 million** (more than half of what was projected)
- Main projects prosecuted in Energy and Mining sector in the last 4 years:
  - III Región: Proyecto Minero El Morro, Cerro Casale, Pascua Lama, Central Castilla y Punta Alcalde
  - XI región: Hidroaysén.
  - XV región: Los Pumas

Ref.: Observatory of Mining Conflicts in Latin America

The new Mine and Mining Facilities Closure Law (Law 20.551)

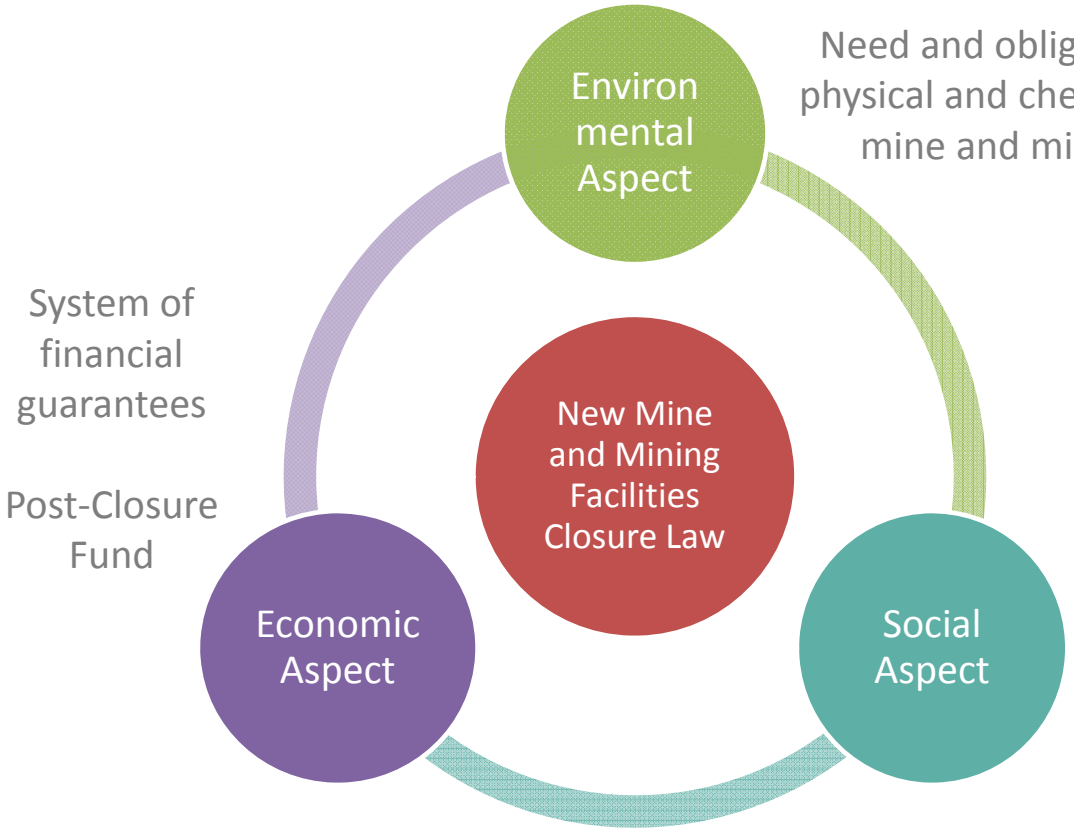
- A new legislation to regulate the negative aspects of the mining industry was needed
- Companies should take charge of their externalities and incorporate them in the business
- Avoid generation of new abandoned facilities
- Guarantee to the State to ensure compliance of the closure measures as indicated in the closure plan

2011 → 2012

For the first time the term "chemical stability" is included

Proyecto apoyado por CORFO

Sustainability Challenge



It constitutes a major challenge towards a more sustainable mining operation, that involves the integrated management of massive mine waste and mine facilities during the life cycle of a mining project

Proyecto apoyado por CORFO

What's happening?

- **134** mine sites presented its closure plans **last November 11th** under the new regime, for a total of **US$12.238 millions** approximately.
- In terms of chemical stability, they presented the valuation of measures committed in their environmental qualification resolutions.
- They will have to **update** their closure plans, measures and valuation **every 5 years.**
- Evaluation of environmental assessment of new expansion projects show that the authorities are more demanding and are focused on **prevention, mitigation** and **repair.**
- To grant environmental permits, authority is requiring measures implemented both for **operation** and **closure**, as well as an evaluation of the effectiveness of these.

Proyecto apoyado por CORFO

The massive mine waste production…

Cu production in 2013 = 5.851.120 tonnes

650.000 tons of tailings per day

3.000.000 tons of waste rock dumps per day

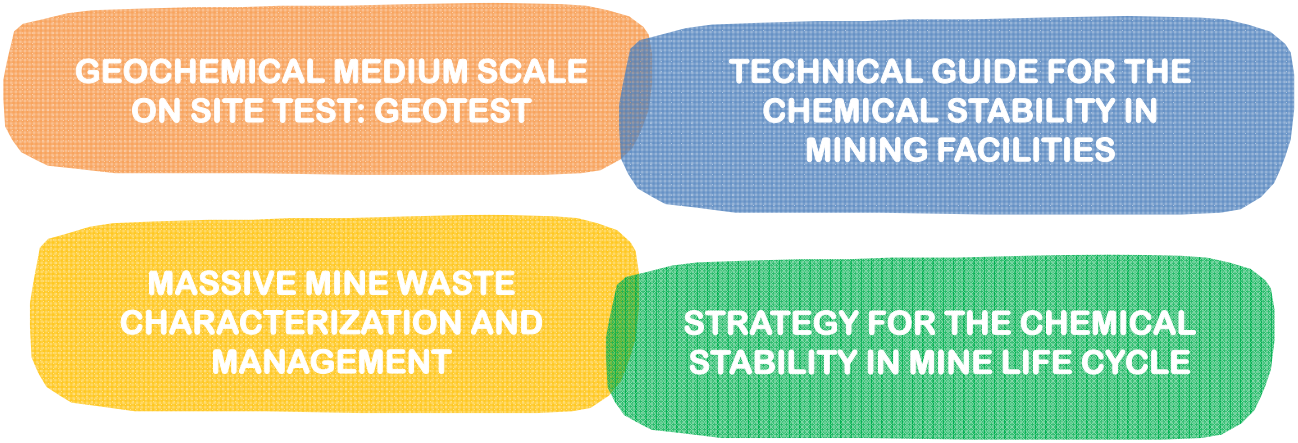
Copper mines located in north and central Chile

Most of mines occur in the arid and semiarid northern section of the country

Most of actual operating mine sites do not have implemented prevention, mitigation or control measures. Some of them doesn't even have characterized their materials…

The role of Fundación Chile

- Generate tools and find solutions to support challenges of the industry
- Technology transfer
- Generation and dissemination of information
- Innovation

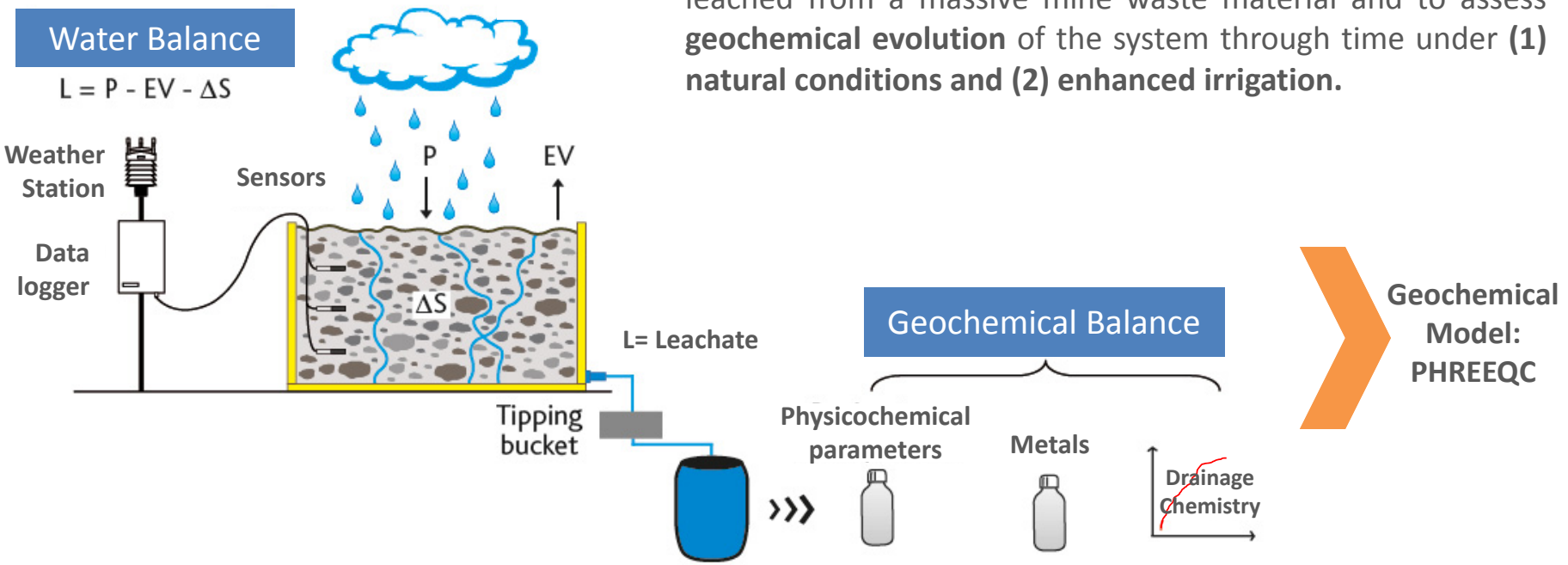


Proyecto apoyado por CORFO

GEOCHEMICAL MEDIUM SCALE ON SITE TEST: GEOTEST

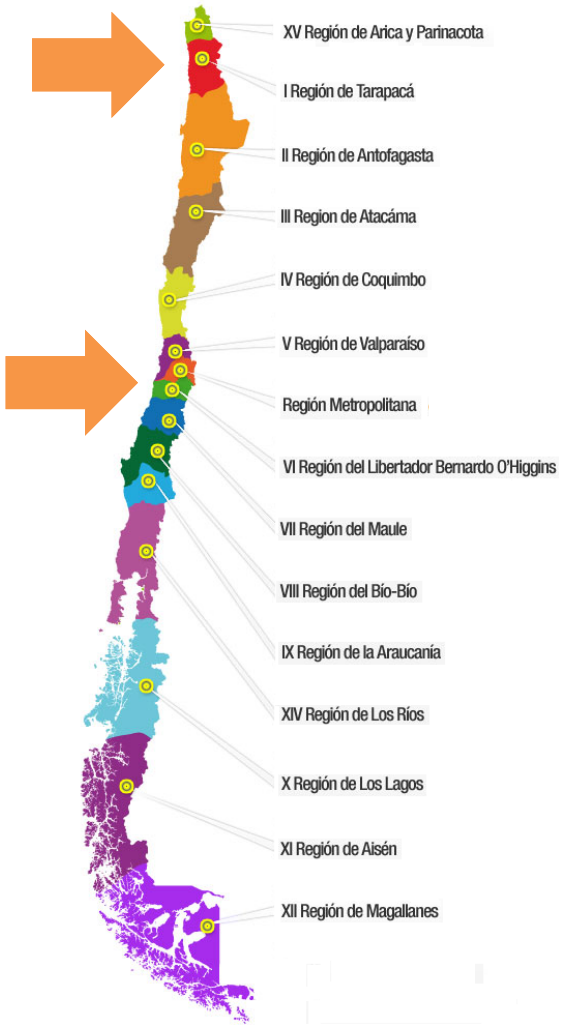
FUNDACIÓN CHILE

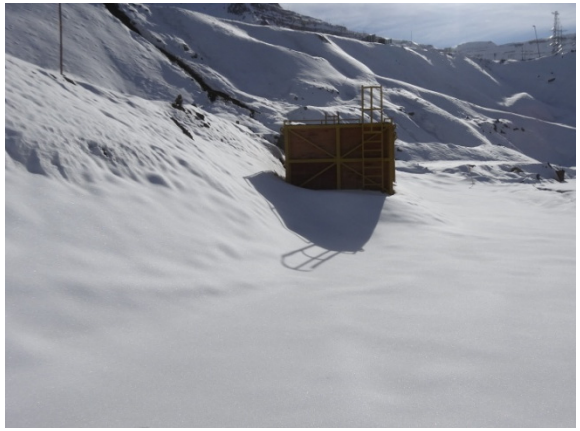
Geochemical field test **to evaluate and monitor** the drainage leached from a massive mine waste material and to assess **geochemical evolution** of the system through time under **(1) natural conditions and (2) enhanced irrigation.**

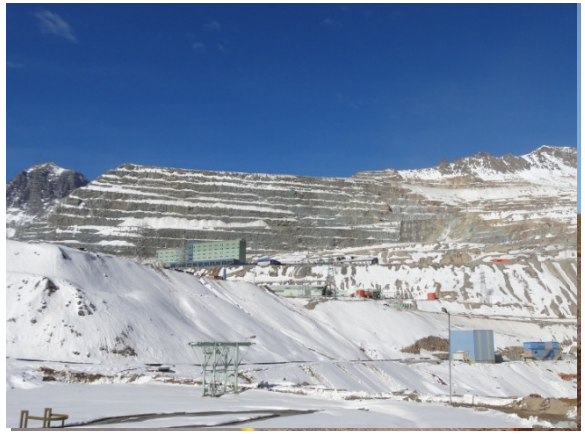


Implemented in two different mine sites

FUNDACIÓN CHILE

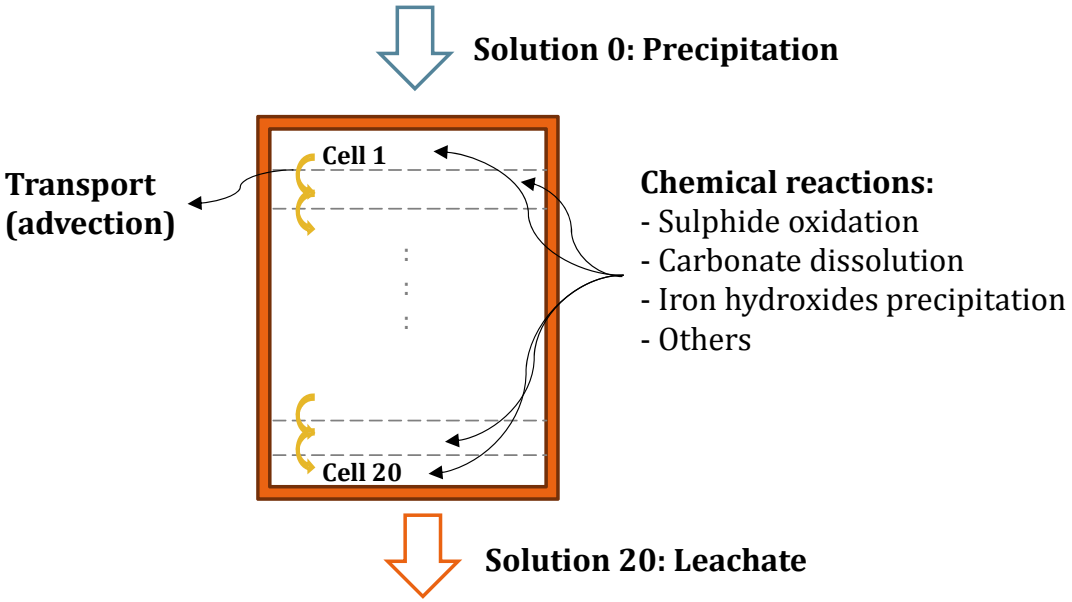






Modelling

- Conceptual model (reactive transport)



✓Preliminary 1D cell model

✓Model is calibrated with real monitoring results

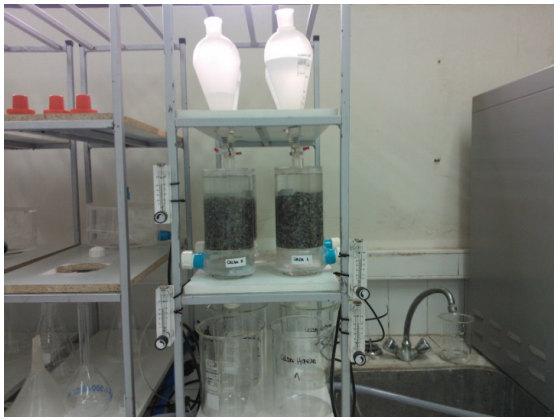
✓ It allows to understand which minerals controls pH, alkalinity o sulphate concentration

✓Preliminary model includes some reactive minerals and kinetic reaction of pyrite

Proyecto apoyado por CORFO

Future work: Scaling laboratory results

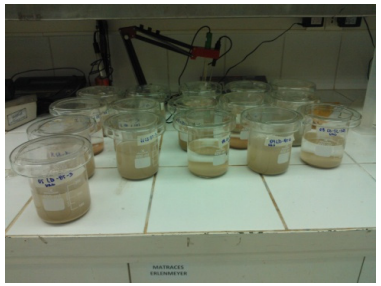
- Pilot in Central Chile has been recently implemented in the minesite
- 4 Humidity Cells have been implemented in Fundación Chile's laboratory with the same material of on-site test but two different grain sizes
- Cycles consist in 3 days of dry air (10% moisture), 3 days of moisture air (90% moisture), irrigation on day 7, with 1 L of distilled water

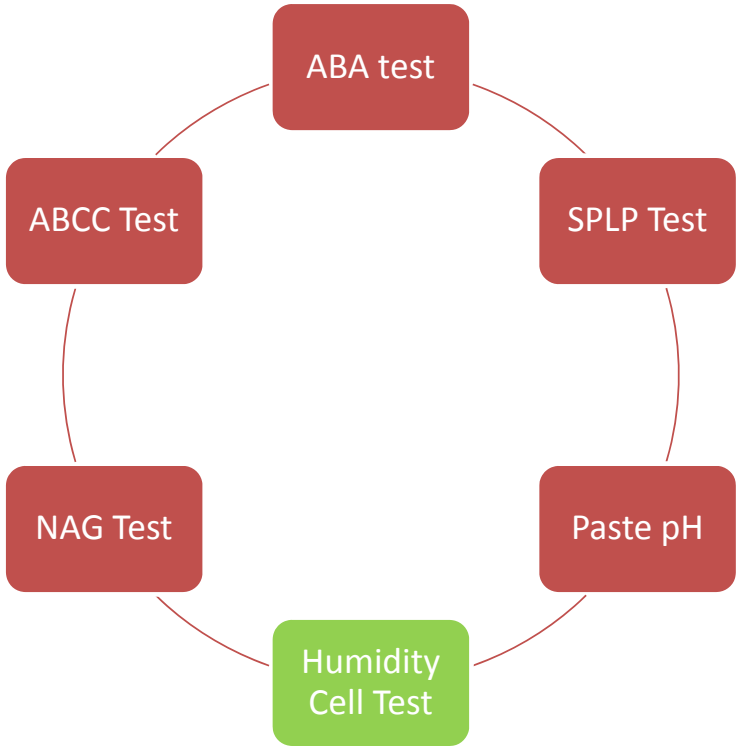


MASSIVE MINE WASTE CHARACTERIZATION AND MANAGEMENT

FUNDACIÓN CHILE

- Geochemical laboratory for the development of standard prediction static and kinetic test
- Development of adapted test (adaptation of procedures like ABCC test, simulate real oxidation conditions)



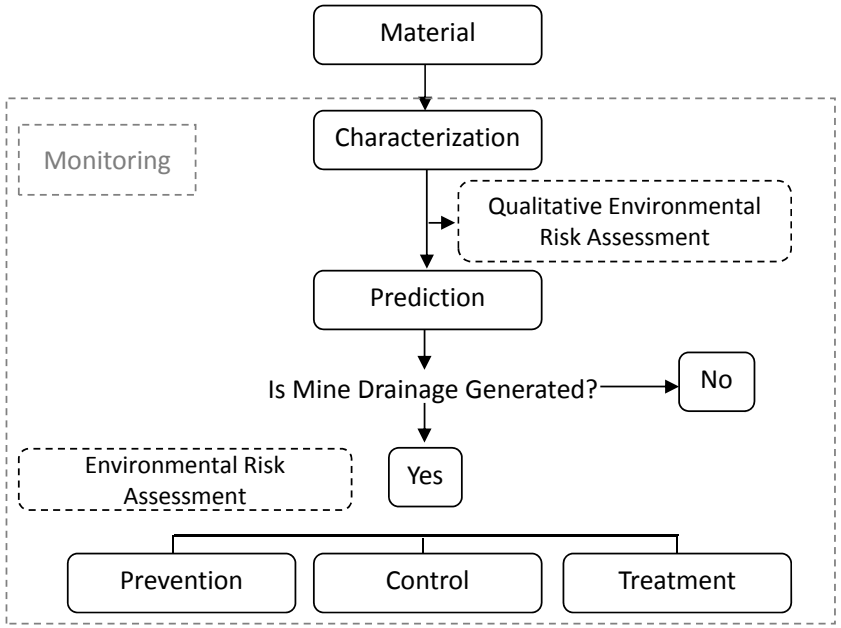


Proyecto apoyado por CORFO

TECHNICAL GUIDE FOR THE CHEMICAL STABILITY IN MINING FACILITIES

FUNDACIÓN CHILE

- Development, Evaluation and Adaptation of Tools and Criteria for Chemical Stability
- Public-private workshops are been developed with multidisciplinary stakeholders
- To introduce the concept of a Chemical Stability Program
- Other product are a Manual of Best Management Practices in Chemical Stability for artisanal mining, and a Technology Registry for Chemical Stability

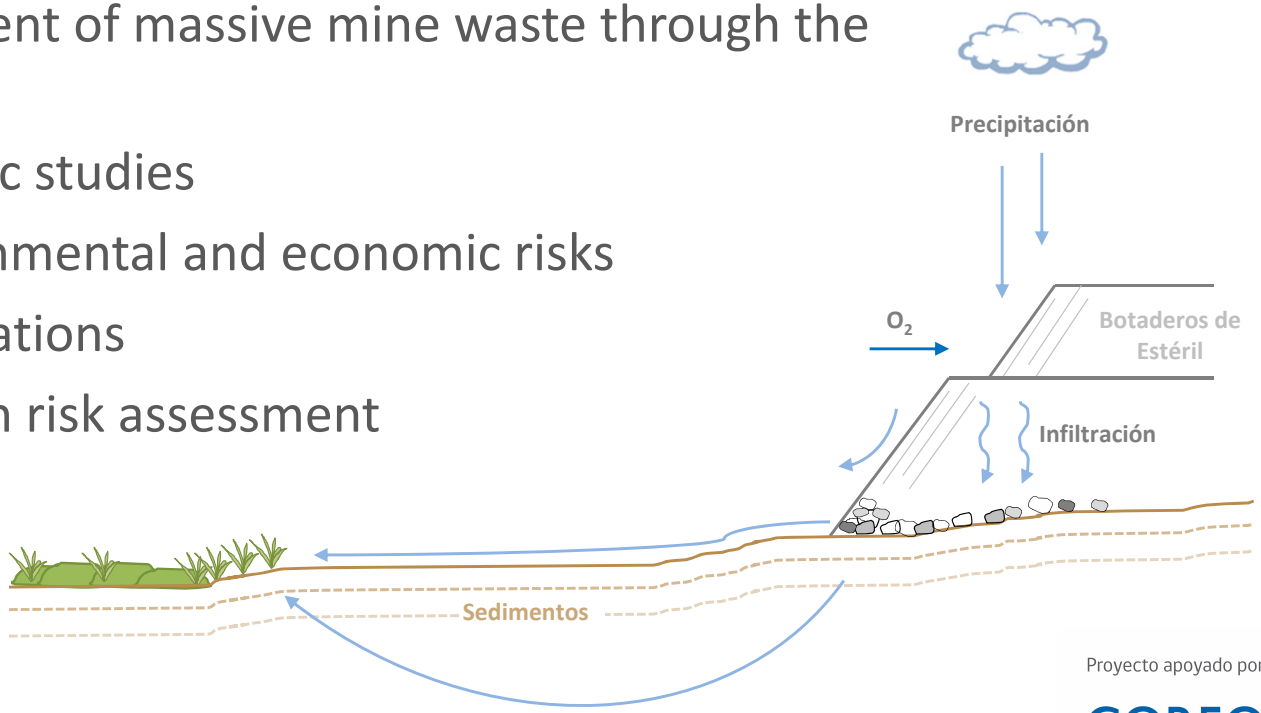


Proyecto apoyado por
CORFO

STRATEGY FOR THE CHEMICAL STABILITY IN MINE LIFE CYCLE

FUNDACIÓN CHILE

- Site specific
- Strategy to ensure chemical stability, based on the integral management of massive mine waste through the minesite lifecycle
- Optimize diagnostic studies
- Minimizing environmental and economic risks
- Comply with regulations
- Approach based on risk assessment



Proyecto apoyado por
CORFO

Thanks for your attention…

Contact

mcarolina.soto@fch.cl

Proyecto apoyado por