ecometales LIMITED

FILIAL CODELCO

TOWARDS A SUSTAINABLE MINING INDUSTRY: THE EXPERIENCE OF ECOMETALES

Iván Valenzuela

CEO, EcoMetales Limited

Santiago, Junio 2017

Environmental solutions for the mining industry

The challenge to concentrate impurities

ecometales LIMITED
FILIAL CODELCO

Increasing limits to smelter emissions **(SO_2, As, Hg).**

Impact on environmental footprint profile of products **(e.g.; cathodes).**

Decreasing maximal aceptable levels of impurities in some markets **(e.g., China; As,<0.5%).**

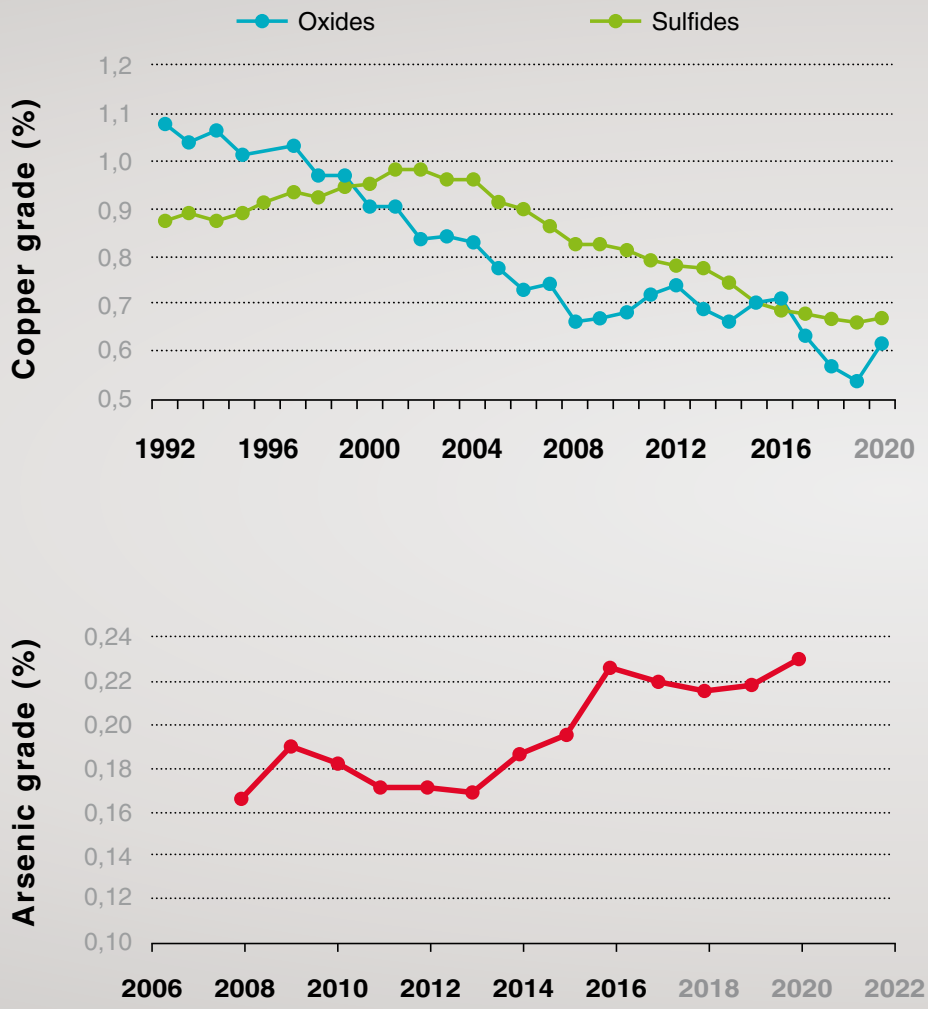
Conflicts with local communities to transportation routes or unloading and storage facilities.

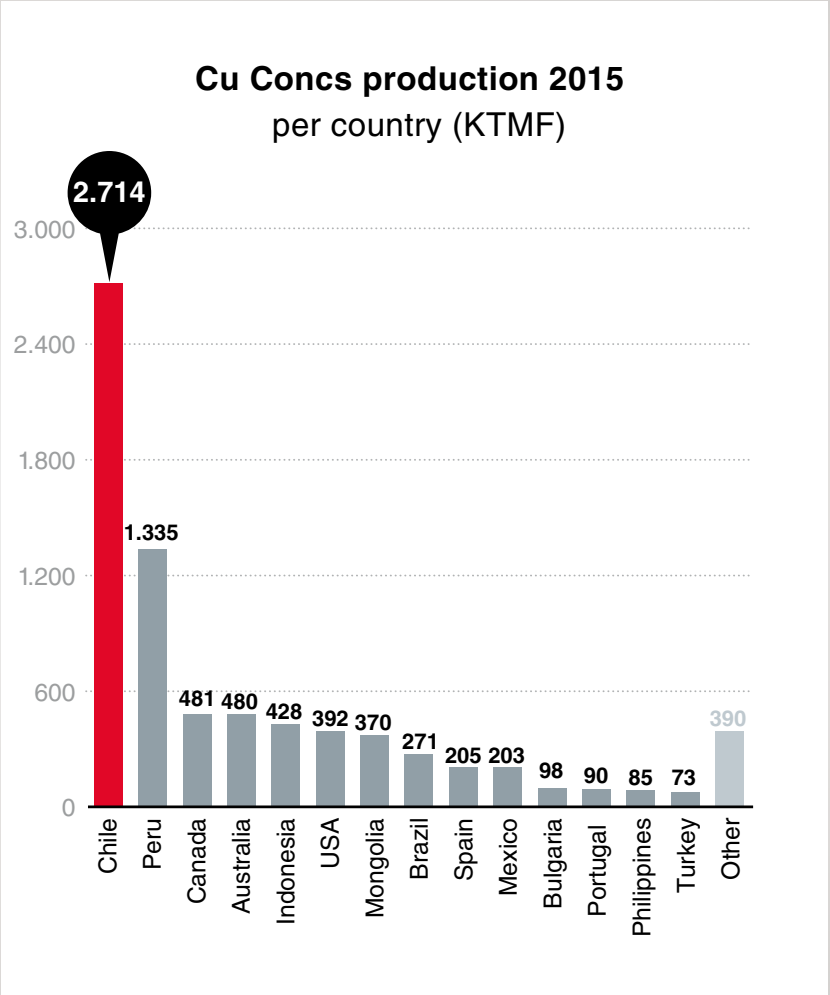
Increasingly restrictive Occupational Exposure Levels (OEL) in processing facilities.

Impact on hazard classification of concentrates and the associated handling and transportation restrictions (e.g.; MARPOL Annex V restrictions for transportation of bulk products by sea)

Arsenic in the copper mining industry

ecometales LIMITED
FILIAL CODELCO





Sources: Codelco and COCHILCO (2016).

The hidden potential of impurities

ecometales LIMITED
FILIAL CODELCO

Waste of primary mining contain traces that are both impurities and resources

Example of composition of a Cu Concs

- Most of these elements end up in wastes.
- The challenge is decreasing the undesirable impurities and at the same time...
- Recover some of them as resources.

Element	%	Elemento	%	Elemento	%
Berilio	< 0,00005	Zinc	2,65	Potasio	0,41
Magnesio	0,07	Arsénico	1,62	Lantano	0,0010
Aluminio	1,16	Molibdeno	0,0400	Sodio	0,04
Calcio	0,29	Plata	>0,01	Fósforo	0,0130
Azufre	33,4	Cadmio	0,0185	Escandio	<0,0001
Titanio	0,08	Antimonio	0,1380	Estroncio	0,0115
Cromo	0,0008	Bario	0,0100	Torio	<0,002
Manganeso	0,0334	Cesio	0,000086	Talio	0,0010
Hierro	19,8	Mercurio	0,000304	Uranio	0,0010
Cobalto	0,0050	Plomo	0,25	Vanadio	0,0021
Niquel	0,0048	Bismuto	0,0019	Wolframio	0,0050
Cobre	27,9	Galio	0,0010		

EcoMetales Limited

About us

A flue dust leaching plant followed by a selective arsenic precipitation plant from existing facilities (BioCOP).

• **ECL** , 100% subsidiary of CODELCO, focused on deliver environmental solutions and value recovery for mining residues.

• **ECL** has a total workforce of about 300 people and is supported by 250 environmental permits.

• **ECL** has processed more than 400,000 tons of residues recovering 80,000 tons of copper. Since the start-up of the As stabilization plant, more than 7,500 tons of arsenic have been stabilized.

Key issues for the project development

- Long-term vision, discipline and willingness to take risks.
- The need for low-cost solutions.
- Lack of availability of solutions on the market.
- Focused research.
  Pilot trials to elucidate unknown process variables and scale-up.
- **Brownfield project**
  The need of optimizing existing facilities.

Arsenic stabilization

ecometales LIMITED
FILIAL CODELCO

Alternatives

Scorodite in atmospheric conditions:

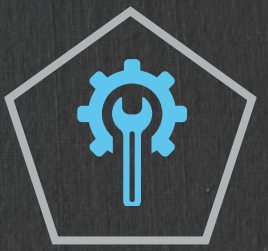
- EcoMetales and Dowa process.

Scorodite in Autoclave:

- (POX Process).

Other alternatives in the Industry:

- Calcium arsenite
- Arsenical ferriydrite.
- Arsenic Trisulphide.



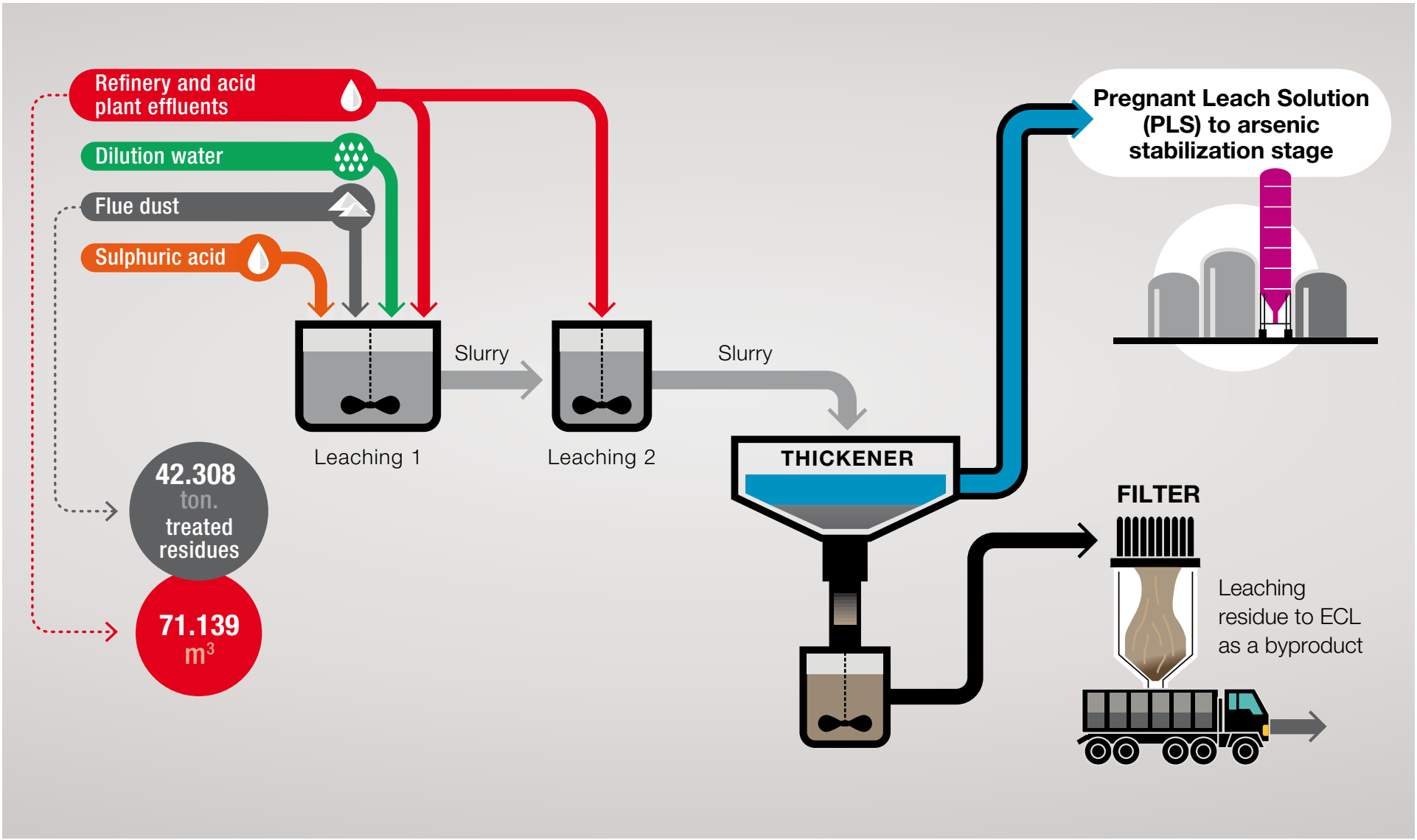
Alternatives at pilot scale:

- Bio scorodite
- As in glass

EcoMetales Plant:

Flue dust leaching process

ecometales LIMITED
FILIAL CODELCO

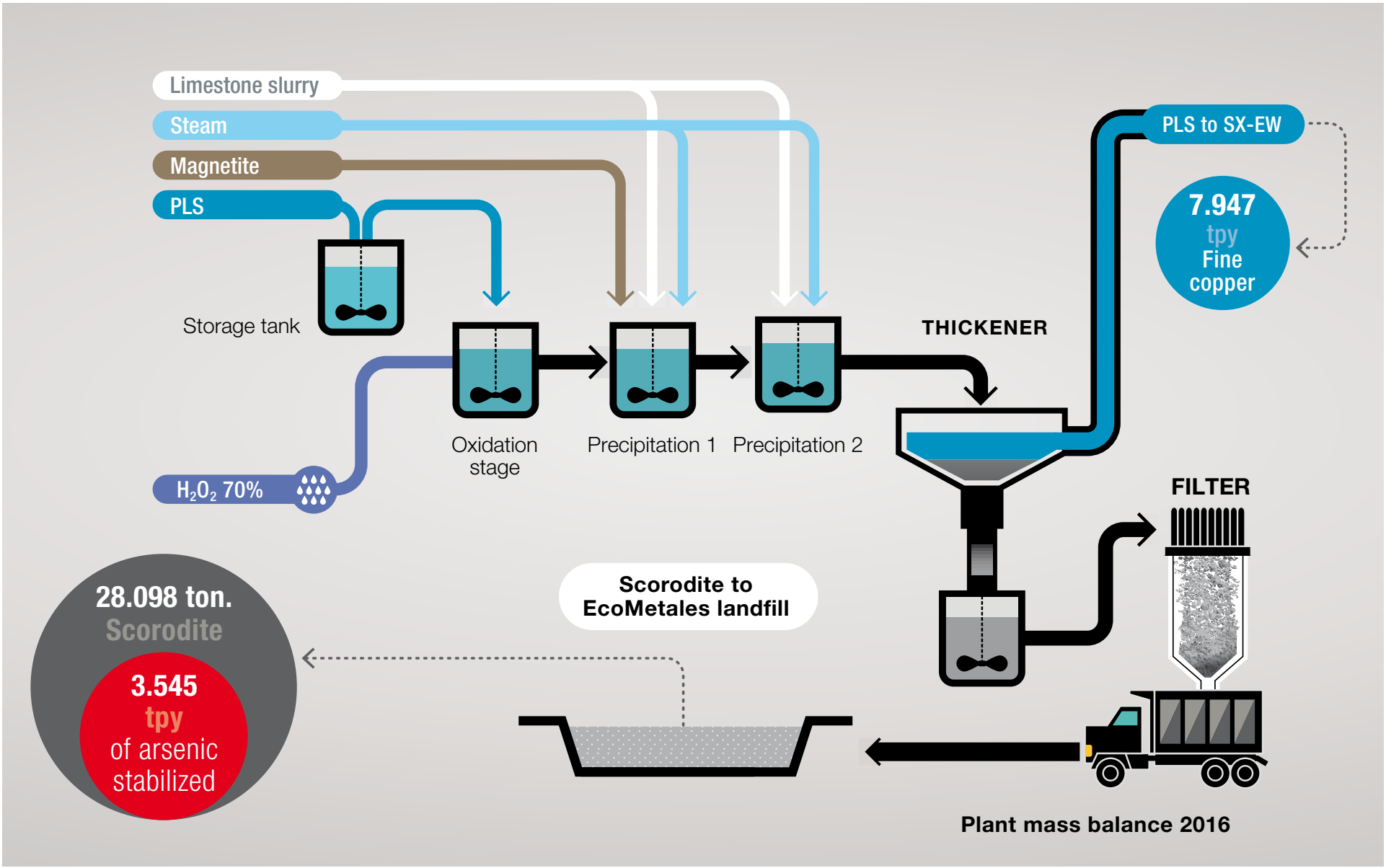


Reference, EcoMetales 2016.

EcoMetales Plant:

Arsenic stabilization process

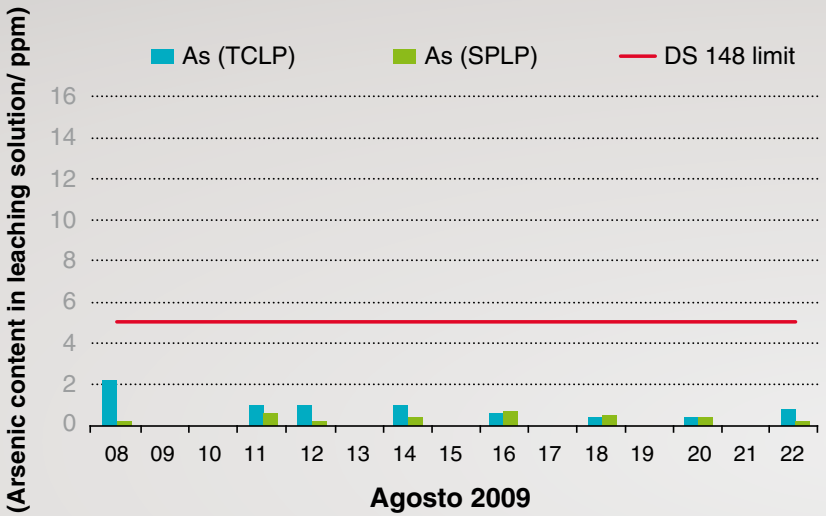
ecometales LIMITED
FILIAL CODELCO



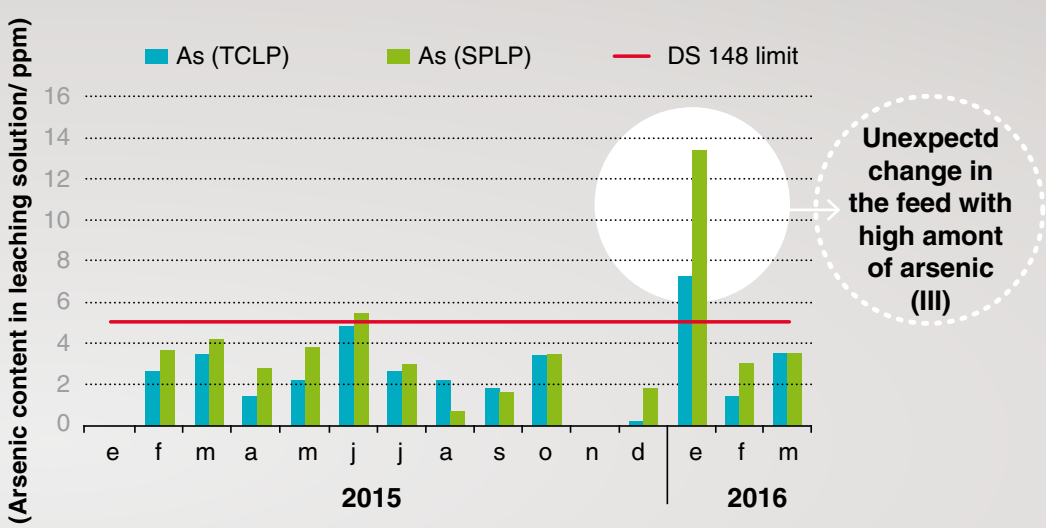
TCLP/SPLC Stability tests

ecometales LIMITED
FILIAL CODELCO

Pilot test result



Industrial test result



Key for good TCLP/SPLP results at industrial scale

Ensure a crystalline shape of scorodite. We check this parameter every 10 days using XRD analysis.

A very important issue is the cake washing in the dewatering stage.

The particle size should hopefully be over 5 microns controlled by the seeding, mixing and HRT.

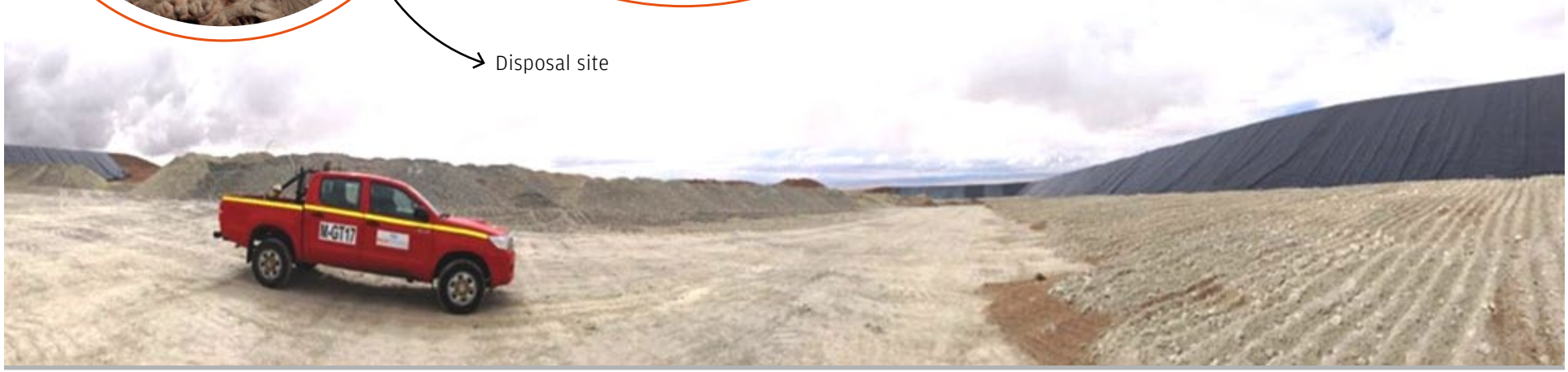
EcoMetales stable residue landfill

ecometales LIMITED
FILIAL CODELCO

Surface area:
hectares
25

Estimated lifespam:
years
15

Ton storage capacity
1.370.000



The Greatest Challenge

The construction of an industrial plant based on a paper.

ecometales LIMITED
FILIAL CODELCO

Continuous learning during the plant operation

2006
Precipitation of scorodite at laboratory scale.

2010-2012
PAA Project.
Pilot Plant Trials.
PAA Construction.
PAA Start-up.

2013
Start of operation of PAA.

2014
Improvement of boiler use and limestone preparation stage.

2015
Optimization of ferric solution preparation stage.

2016
Improvement of oxidation stage.

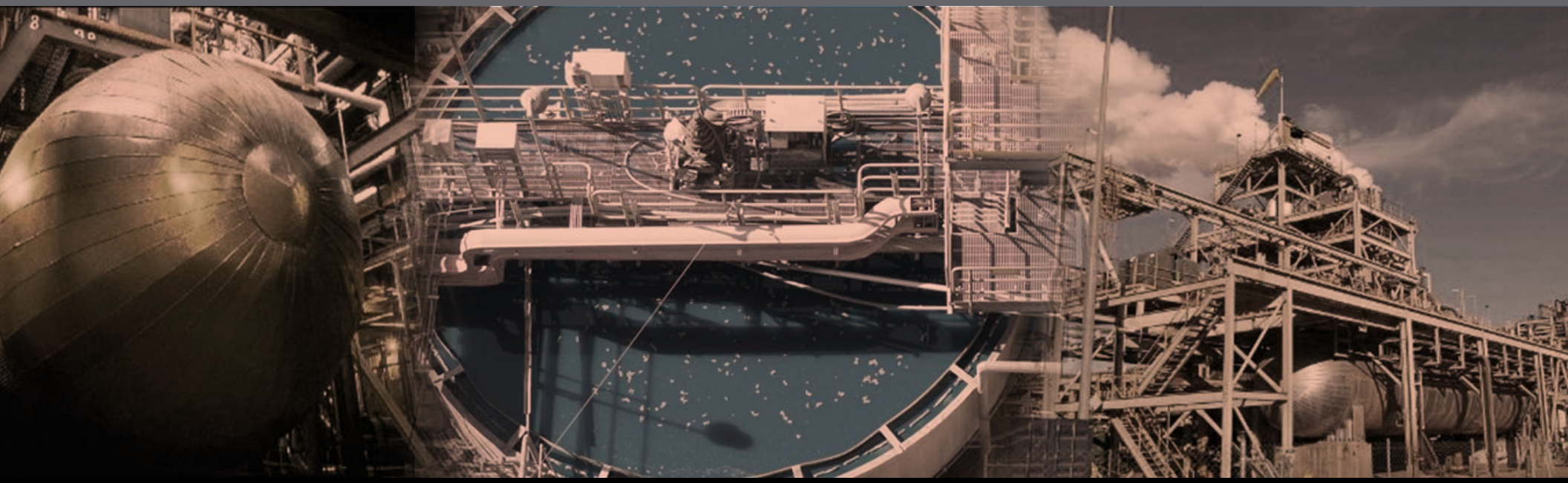
2017
Optimization of precipitation stage.

2018
Improvement of automatic control.

ecometales LIMITED
FILIAL CODELCO

EcoMetales

Growth opportunities and development projects



Complex Concentrate Leaching Project (PLCC)

Arsenic stabilization at high pressure

ecometales LIMITED
FILIAL CODELCO

The process considers the leaching of complex copper concentrates through a high-pressure vessel. The arsenic stabilization is also performed inside the vessel.

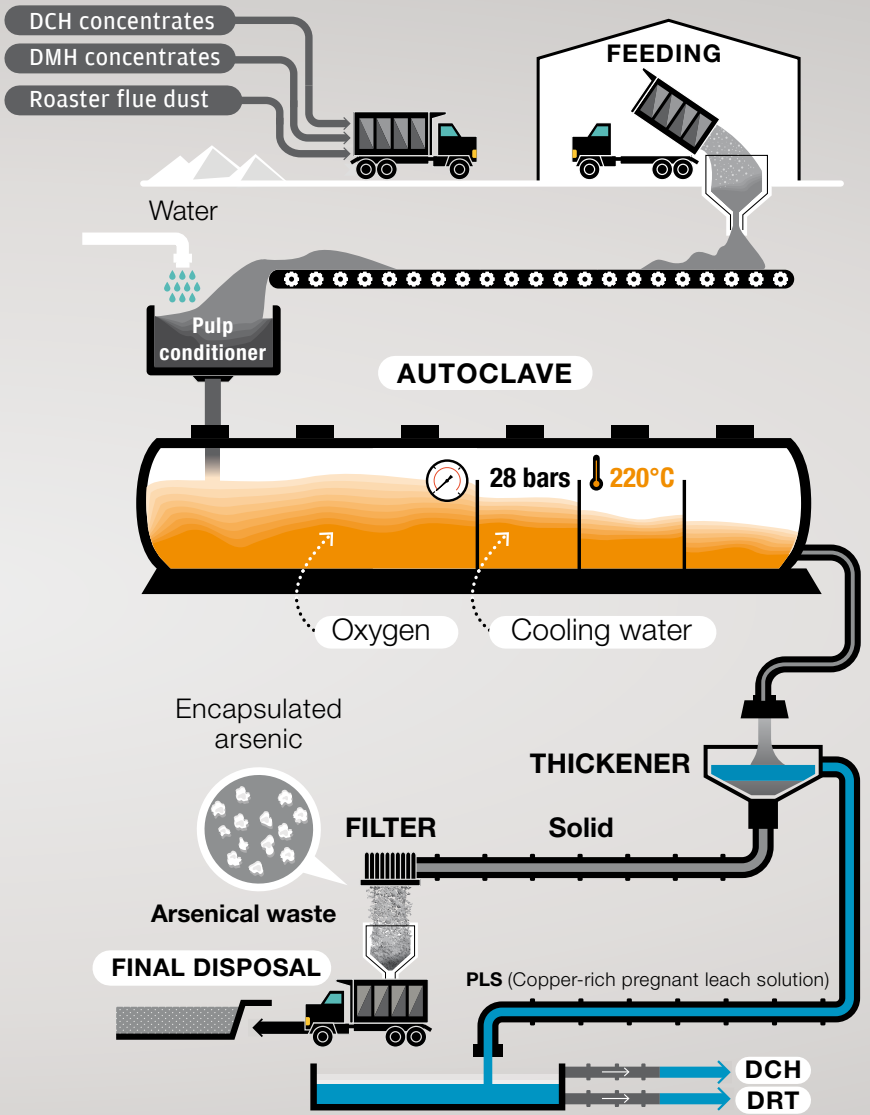
The project capacity is 200,000 t/y, the go-ahead decision should be taken during 2017.

Advantages:

- Almost zero emission
- Stable residue as scorodite
- Utilization of existing SX-EW facilities
- Low water consumption
- Competitive costs

The schedule defines the start-up for the new facilities in 2020.

Capex USD $ 324.000.000



New developments

Part of the next years

ecometales LIMITED
FILIAL CODELCO

- Recovery of trace elements (Ag, Bi, Sb and Ge) from the flue dust treatment.
- Tailing treatment for recovery of minor elements.
- Increase of current copper recovery of flue dust treatment plant.
- Treatment of Acid Mine Drainage (AMD).

Stable waste and metal recovery:

Exciting market for sustainable mining industry

ecometales LIMITED
FILIAL CODELCO

- Decreasing the costs of the stabilization process.
- Minimizing the volume of waste.
- Full stability of residues.
- Recovering value from byproducts and “impurities”.
- Recycling the waste.

- Strategic alliances (universities, research centers, tech companies).
- Participation of public and private investment funds to develop environmental solutions.

- Sustainable processes for stabilizing the waste.
- Value recovery from waste.
- Circular economy as a driving force (tailing treatment, among others).

We require long-term solutions

ecometales LIMITED
FILIAL CODELCO

For treating or recovering complex materials, the dilution is not a solution. It may solve short-term issues but it kicks the problem forward.

Safe disposal or, better yet, recovery of impurities as values leads to long-term sustainability.

What is our legacy for future generations?

A challenge from both ethical and business viewpoints

ecometales
LIMITED

FILIAL CODELCO

Contact us for further information

072 Nueva de Lyon St., Floor 17th Providencia, Santiago, Chile.
Ph. (56 2) 2378 4100
Fax. (56 2) 2378 4111

www.ecometales.cl

Road to Radomiro Tomic Km. 16 ½ Calama, Antofagasta, Chile.
Ph. (56 55) 2320 950