Facing the challenge of a new age:

Chile and mining in the 21st century

COCHILCO – Chilean Copper Commission

Jorge Cantallopts
Research Department

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1. Mining in Chile, a brief summary
Mining in Chile, a brief summary

General facts

Population 2014(e):
- 17,8 million (e)

Surface territorial area:
- 756,950 km²

GDP 2014(e):
- US$250 billion
- Mining GDP: 11%

Sources: Central Bank of Chile, National Statistical Institute
Mining in Chile, a brief summary

Mineral endowment

**Sources:** USGS Mineral Commodity Summaries, COCHILCO

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Mining in Chile, a brief summary

Mining in exports

Source: Central Bank of Chile
Mining in Chile, a brief summary
Fiscal income and FDI

Fiscal income 2014 (e)

FDI 2009 - 2013

Sources: Budget Agency, Foreign Investment Committee
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Mining in Chile, a brief summary
Leading copper production, but…

Source: COCHILCO
Mining in Chile, a brief summary

There’s still job to do

Mining projects 2014 - 2023
(Mill. US$104,851)

- Under construction: 22%
- Probable: 47%
- Possible: 25%
- Potential: 6%

Source: COCHILCO
Mining in Chile, a brief summary
And it’s a global challenge

Copper projects investment 2014 – 2023

Source: COCHILCO, WoodMac

CAPEX intensity in copper projects 2014 – 2023
2. Environmental and social licenses
Environmental and social licenses

- Mine closure
- Smelters emissions
- Local communities
- Human resources
- Water availability
Enviromental and social licenses

- Mine closure
- Smelters emissions
- Local communities
- Human resources
- Water availability
Enviromental and social licenses

Mine closure

• Improvement in legal framework in 2011 lead to new obligations to mining operation related to mining closure.
• In 2014 more than 100 mining operations submit their closure plan.
• Expected value of first approach reach Mill. US$12,238.

Source: National Service of Geology and Mines
In 2013 new policy for smelters emissions was defined.

To meet regulations chilean smelters would require major investment in their acid plants and infrastructure.

There are 7 smelters in Chile with 1,6 Mton anode production.
Enviromental and social licenses

- Mine closure
- Smelters emissions
- Local communities
- Human resources
- Water availability
Several projects have to deal in a new way with society.

Empowered citizens, social awareness, search for mutual benefit and legal framework (C169).
Environmental and social licenses
Human resources

- Almost 35 thousand new jobs in mining:
  - Safety.
  - Disruptions.
  - Work expectancy.
  - Relation with academic institutions.

Source: Mining Council
Environmental and social licenses

- Mine closure
- Smelters emissions
- Local communities
- Human resources
- Water availability
Enviromental and social licenses

Water availability

Water availability in Chile

Average water flow [m$^3$/person/year]

<table>
<thead>
<tr>
<th>Country</th>
<th>Water Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chile</td>
<td>53,000</td>
</tr>
<tr>
<td>World</td>
<td>6,600</td>
</tr>
<tr>
<td>Minimum</td>
<td>2,000</td>
</tr>
<tr>
<td>Chilean northern regions</td>
<td>800</td>
</tr>
</tbody>
</table>

Copper production by region 2013

- Northern regions (I, II, III and IV): 79%
- Other (V, VI and RM): 21%
Enviromental and social licenses

Water availability

Water for mining in selected regions 2013

Forecast of sea water consumption for new mining projects

Source: COCHILCO
3. Costs and productivity challenges
Costs and productivity challenges

- Geology
- Mining costs
- Energy costs and consumption
- Productivity
- Strategic inputs
Costs and productivity challenges

- Geology
- Mining costs
- Energy costs and consumption
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Costs and productivity challenges

Geological context

- Mine production driven by natural conditions:
  - Lower ore grades.
  - Deeper mines.
  - Longer hauling distance.
  - Higher Altitude.
  - Deposits near populated cities.

Source: COCHILCO
Costs and productivity challenges
Geological context

Average ore copper grade and production

Source: WoodMac
Costs and productivity challenges

Mining costs

- Higher cost in high price scenario:
  - Price for strategic inputs.
  - Productivity awareness.

Source: COCHILCO, WoodMac

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Costs and productivity challenges

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Costs and productivity challenges

Electric energy costs

**Comparison of electricity costs in the mining industry, 2000 – 2014**

*($US/MWh)*

**Unit cost of electric power in some mining countries in 2012 ($US/MWh)*

<table>
<thead>
<tr>
<th>Country</th>
<th>Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chile</td>
<td>143</td>
</tr>
<tr>
<td>Argentina</td>
<td>104</td>
</tr>
<tr>
<td>Brazil</td>
<td>96</td>
</tr>
<tr>
<td>Mexico</td>
<td>89</td>
</tr>
<tr>
<td>Avg. of copper mining sector</td>
<td>86</td>
</tr>
<tr>
<td>Australia</td>
<td>82</td>
</tr>
<tr>
<td>Peru</td>
<td>74</td>
</tr>
<tr>
<td>Canada</td>
<td>69</td>
</tr>
<tr>
<td>South Africa</td>
<td>61</td>
</tr>
<tr>
<td>USA</td>
<td>59</td>
</tr>
</tbody>
</table>

*Source: COCHILCO, WoodMac*

*Argentina, Australia, Brazil, Canada, Chile, China, Congo, Indonesia, Kazakstan, Mexico, Mongolia, Papua NewGuinea, Peru, Philippines, Russia, South Africa, USA, Zambia
Costs and productivity challenges

Energy consumption

[Graph showing energy consumption trends from 2000 to 2025]

Base year 2000 = 100

- Open pit [MJ/ton]
- Milling [MJ/ton ore]
- Leaching [MJ/ton ore]
- Underground mine [MJ/ton]
- Smelter [MJ/ton con.]

Energy consumption forecast

+96%

Source: COCHILCO
Costs and productivity challenges
Costs and productivity challenges

Productivity measures

- Productivity concerns led institutions to take into account economic performance of industry.
- During commodities super cycle data shows a clear decline in productivity.

Sources: CLAPES - UC, CORFO - UAI
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Costs and productivity challenges
Productivity measures

**Chilean copper mines TFP**

Base year 2000 = 100%

**Input index**

Base year 2000 = 100

Source: COCHILCO
Ministry of Mines | COCHILCO
Costs and productivity challenges
Productivity measures

Labor productivity in copper mines 2011 (Kg Cu/HH)

- USA: 41
- Australia: 41
- Mexico: 37
- Argentina: 34
- Peru: 33
- Canada: 30
- Chile: 29
- New Guinea: 28
- Brazil: 21
- South Africa: 21
- Indonesia: 13

Source: COCHILCO, Mining Council
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Costs and productivity challenges

- Geology
- Mining costs
- Energy costs and consumption
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- Strategic inputs
Costs and productivity challenges

CAPEX strategic inputs

Source: COCHILCO

Ministry of Mines | COCHILCO
Costs and productivity challenges

CAPEX strategic inputs

• Higher share in total cost and higher availability risk:
  - SAG, ball and bar mills (Mill).
  - Milling infrastructure (Mill).
  - Mineral conveyor (Leaching).
  - Geomembrane (Leaching).
  - Trucks and Electric Shovel (Open Pit).
Costs and productivity challenges
OPEX strategic inputs

Source: COCHILCO

Ministry of Mines| COCHILCO
Costs and productivity challenges
OPEX strategic inputs

• Higher share in total cost and higher availability risk for every process:
  o Electric energy (Leaching, Mill, Sea water pumping).
  o Fuel (Open Pit).
  o Fresh water (Mill).
  o Materials and Replacement parts (Underground Mine, Open pit and Mill).
  o Sulphuric Acid (Leaching).
  o Flotation reagents (Mill).
  o Steel balls and bars (Mill).
4. Final comments
Final comments

• Chile has been recognized as a major center for mining investment.

• Mineral endowment and projects support mining production forecasting.

• Challenges arise from several interacting factors:
  o Environmental.
  o Local communities
  o Productivity.
  o Costs
Final comments

- Lower grades and other natural conditions of deposits encourage the need to sustain mining development.
- Technology, innovation, changes in processes, community relation models and costs restraints are leading efforts of mining activity in Chile.
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