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COBRE LAS CRUCES, S.A. – Seville, Spain

POLYMETALLIC ORES
HYDROMETALLURGICAL PROCESSING

CARLOS FRIAS, Technology and Innovation Director
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**MINE ACQUIRED BY FQM IN MARCH 2013. RELEVANT FIGURES:**

<table>
<thead>
<tr>
<th>ORES RESERVES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ SECONDARY COPPER SULPHIDES (Actual)</td>
<td>&gt;10 M t, 5.5% Cu</td>
</tr>
<tr>
<td>▪ POLYMETALLIC SULPHIDES (Future)</td>
<td>&gt;20 M t, 1.4% Cu, 3.0% Zn, 1.6% Pb</td>
</tr>
<tr>
<td>LIFE OF MINE (Secondary Copper Sulphides)</td>
<td>&gt; 7 Years</td>
</tr>
<tr>
<td>NOMINAL CAPACITY</td>
<td>72,000 t/y Cu Cathodes, Grade A</td>
</tr>
<tr>
<td>DIRECT EMPLOYMENT / INDUCED EMPLOYMENT</td>
<td>800 / 1,500</td>
</tr>
<tr>
<td>TOTAL INVESTMENT FOR PROJECT START UP</td>
<td>850 Million €</td>
</tr>
</tbody>
</table>

**RELEVANT RESULTS**

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>YEARLY INCOME</td>
<td>425 Million €</td>
</tr>
<tr>
<td>GROSS MARGIN</td>
<td>215 Million €</td>
</tr>
<tr>
<td>NET PROFIT</td>
<td>130 Million €</td>
</tr>
</tbody>
</table>

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No task is so important that it cannot be conducted safely.
A Premier Base Metals Company
Seven producing mines and six world class projects across eight countries and five continents.

Unmatched Portfolio of World Class Development Projects
- Kansanshi Expansion and Smelter, Zambia (Cu Au)
- Sentinel, Zambia (Cu)
- Enterprise, Zambia (Ni)
- Cobre Panama, Panama (Cu Au Ag Mo)
- Haquira, Peru (Cu)

Solid Platform of Diversified, Stable Operations
- Las Cruces, Spain (Cu)
- Kevitsa, Finland (Ni Cu)
- Pyhäsalmi, Finland (Cu Zn)
- Çayeli, Turkey (Cu Zn)
- Guelb Mogrein, Mauritania (Cu Au)
- Ravensthorpe, Australia (Ni Co)
- Kansanshi, Zambia (Cu Au)

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THE IBERIAN PYRITE BELT, IPB

- Covers a territory of 240 km by 35 km in Spain and Portugal
- Estimated current resources are over 1,500 million tonnes of primary massive sulphides
- Mined more than 5,000 years, having over 200 mines open along the times

- The industrial-scale mining exploitation started at the end of XIX century mainly focused on copper extraction and pyrite for sulphuric acid production
- The modern mining projects were developed along the 70’s and 80’s of the XX century and aimed to produce copper, zinc, and lead concentrates through selective flotation

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RUNNING MINES

- PORTUGAL: ALMINA, SOMINCOR
- SPAIN: AGUABLANCA, AGUAS TEÑIDAS, COBRE LAS CRUCES

MINES IN RE-OPENING PROCESS

- PORTUGAL: LAGOA SALGADA
- SPAIN: RIOTINTO, SOTIEL-MIGOLLAS, AZNALCOLLAR-LOS FRAILES, LOMERO POYATOS, LA ZARZA, THARSIS-FILON SUR, ETC.

NEW PROJECTS / NEW DISCOVERIES

- PORTUGAL: SEMBLANA
- SPAIN: MASA VALVERDE, LA MAGADALENA

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ALJUSTREL MINE, PORTUGAL

- Between 1971 and 1990 Aljustrel mine produced 1.5 million tonnes of ores used for the production of sulphuric acid and recovery of some metals, e.g. Zinc cathodes, through hydrometallurgical ways. In 1991 the Moinho plant started production of selective Cu, Zn and Pb concentrates but the low prices of these metals forced the mine closure in 1993. The Almina Company re-opened the mine in 2012 and is producing copper concentrates; zinc concentrates production by selective flotation is under development.

NEVES CORVO MINE, PORTUGAL

- Neves Corvo mine includes five massive sulphides orebodies and has recently discovered a new one, Semblana (resources: 7.8 Mt, 2.8% Cu). Previously, there were a copper plant and a copper-tin plant using flotation and gravity methods for ore concentration. Currently, there are two flotation plants: the copper plant capacity is 2.5 Mt ores/year and the zinc plant capacity is 1.0 Mt ores/year. In 2013, Neves Corvo produced 56,500 t of Cu and 53,400 t of Zn contained in concentrates.

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SOTIEL-MIGOLLAS, SPAIN
- Operation was started in 1983, having a flotation capacity of 600,000 t/y polymetallic ores and producing Cu, Zn and Pb selective concentrates, as well as, sulphuric acid through pyrite roasting. Typical production (metals in concentrates) was about 8-10,000 t/y Cu, 9-10,000 t/y Pb, 35-40,000 t/y Zn. This mine was shut down in 2002 due to metals market depression. Currently, the Trafigura Beheer B.V. group is re-starting the exploitation of the Migollas deposit.

AZNALCOLLAR-LOS FRAILES, SPAIN
- Aznalcollar deposit was exploiting during the 60’s and exhausted in 1973. Los Frailes deposit started its operations in 1980, and the mine was acquired by Boliden in 1987. Los Frailes open pit was producing selective concentrates of Cu, Zn and Pb; typical production (metals in concentrates) were about 5-6,000 t/y Cu, 110-120,000 t/y Zn, 30-40,000 t/y Pb. This mine ceased operations in 2001, three years after the disaster of tailings dam failure. Presently, a tender to re-open Los Frailes mine is underway by Andalusian Government and Grupo Mexico is one of the bidders.

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AGUAS TEÑIDAS, SPAIN

- Owned by Trafigura Beheer B.V. The operation was started in 2009. It is an underground mine processing 1.2 million tonnes a year of polymetallic ores through differential flotation process to produce selective Cu, Zn and Pb concentrates. Production from polymetallic ores (metals in concentrates) is about 15,000 t/y Cu, 55,000 t/y Zn, 10,000 t/y Pb and relevant revenue from silver and some gold. This mine is currently involved in an expansion project to build a new concentration plant having a capacity of 2.2 million t/y massive sulphides ores.

New discovery made by Aguas Teñidas company is the high grade La Magdalena deposit which is currently under evaluation and will be developed in the next years.

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IPB: High grade deposits are abundant

PORTUGAL: NEVES CORVO (4-10% Cu); SEMBLANA (>3% Cu)
ALJUSTREL (>3% Cu Eq.)

SPAIN: COBRE LAS CRUCES (>5% Cu); AGUAS TEÑIDAS ( >4% Cu Eq.)
LA MAGDALENA (>4% Cu Eq.); LOS FRAILES (>2% Cu Eq.)

Source: Brook Hunt . Rio Tinto Analysis, National Institute of Statistics Chile and Peru
Treatment processes for the beneficiation of polymetallic ores from the IPB are the most complex of all sulphide ores processed. The flotation behaviour of the individual minerals makes it difficult to achieve efficient separation and therefore the treatment process is tailored based on characteristics of the individual ores types. There are two traditional processing techniques at the IPB mines:

- Sequential Cu, Pb, Zn flotation method producing three selective concentrates
- Semi-bulk Cu/Pb flotation, followed by Zn flotation; the Cu and Pb separation is performed on the upgrade Cu/Pb conc.

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Polymetallic ores contain interstitial and microcrystalline minerals requiring very fine liberation size (10-15 microns)

Comminution is highly energy intensive and extremely costly

It is very difficult to separate each metallic mineral to achieve qualified commercial conc. and high metals recovery rates

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Semibulk Cu/Pb & Zn Flotation

- Poor recovery is achieved in many mines: <65% Cu, <75% Zn, <50% Pb
- In many cases, produced concentrates have low grade and contain high level of impurities such As, Sb, Bi, Hg, etc
- Produced selective concentrates incur penalties in toll smelting contracts

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Ore crushing and milling. Bulk flotation is simpler and less costly than selective flotation, for example, not very fine grinding is required to liberate minerals species from the pyrite matrix.

Bulk flotation. It is possible to achieve a bulk concentrate having a weight ratio of 25-35% of feed ore containing over 90% of the metals.

Copper and zinc leaching. Ferric sulphate media and oxygen addition is the preferred technology, and different conditions may be applied:

- Pressure leaching, e.g. partial or total sulphides oxidation
- Atmospheric leaching, e.g. existing leaching reactors at Cobre las Cruces mine after proper process adaptation

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HYDRO PROCESSING: Pressure Leaching

Bulk concentrate is processed through pressure leaching. Cu and Zn are put in solution and next recovered by means of SX+EW, producing high quality metals.

New process steps to be implemented at CLC factory:
- Bulk flotation
- Autoclave
- Zn SX
- Pb & Ag recovery

CONCEPTUAL PROCESS DIAGRAM (Pyrite fully oxidation)
HYDRO PROCESSING: Atmospheric Leaching

- Bulk concentrate is processed through atmospheric leaching. Cu and Zn are put in solution and next recovered by means of SX+EW, producing high quality metals.

- New process steps to be implemented at CLC factory:
  - Bulk flotation
  - Zn SX
  - Pb & Ag recovery

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COMPARISON OF TECHNOLOGIES

TECHNICAL ECONOMIC ANALYSIS AND COMPARISON:

- Polymetallic ores processing through Selective Flotation
- Polymetallic ores processing through Bulk Flotation & Hydro

DESIGN BASIS

- Cobre las Cruces polymetallic ores deposit, > 25 million t resources
- Plant Throughput: 2.2 million t ores a year
- Life of Mine: 10 years, minimum
- Ore Composition:

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu, %</td>
<td>1.1</td>
</tr>
<tr>
<td>Zn, %</td>
<td>2.7</td>
</tr>
<tr>
<td>Pb, %</td>
<td>1.4</td>
</tr>
<tr>
<td>Ag, g/t</td>
<td>29</td>
</tr>
</tbody>
</table>

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COMPARISON OF TECHNOLOGIES

**SELECTIVE FLOTATION PROCESS. METALS RECOVERY:**

<table>
<thead>
<tr>
<th>Selective Concentrate</th>
<th>Metal recovery %</th>
<th>Amount of metal in concentrate, t/y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu</td>
<td>75</td>
<td>18,300</td>
</tr>
<tr>
<td>Zn</td>
<td>65</td>
<td>38,900</td>
</tr>
<tr>
<td>Pb</td>
<td>40</td>
<td>13,400</td>
</tr>
</tbody>
</table>

(Ag recovered and payable is estimated to be 34.5 t/a)

**BULK FLOTATION AND HYDRO PROCESSING. METALS RECOVERY:**

<table>
<thead>
<tr>
<th>Bulk concentrate</th>
<th>Metals recovery %</th>
<th>Amount of metal in the bulk concentrate, t/y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu+Zn+Pb+Ag</td>
<td>All metals= 90 %</td>
<td>Cu= 22,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zn= 53,900</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pb= 26,700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ag= 56</td>
</tr>
</tbody>
</table>

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COMPARISON OF TECHNOLOGIES

SELECTIVE FLOTATION PROCESS. ECONOMIC FIGURES:

<table>
<thead>
<tr>
<th>Case Study</th>
<th>OPEX MUSD/y</th>
<th>CAPEX MUSD/y</th>
<th>INCOME MUSD/y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selective Flotation</td>
<td>83</td>
<td>330</td>
<td>170</td>
</tr>
<tr>
<td>Bulk flotation &amp; Hydro</td>
<td>105</td>
<td>400*</td>
<td>310</td>
</tr>
</tbody>
</table>

(*) It is assumed that part of existing hydro facilities will be used in this project

BULK FLOTATION AND HYDRO PROCESSING. ECONOMIC FIGURES

<table>
<thead>
<tr>
<th>Case Study</th>
<th>NPV MUSD</th>
<th>IRR %</th>
<th>PAY-BACK y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selective Flotation</td>
<td>70</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Bulk flotation &amp; Hydro</td>
<td>450</td>
<td>32</td>
<td>2</td>
</tr>
</tbody>
</table>

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The IPB mining region in the South of Spain and Portugal represents a very profitable business opportunity for beneficiation of polymetallic massive sulphide ores. Estimated reserves are over 1,500 million tonnes, and the potential for new deposits discovery is extremely high.

Hydrometallurgy is a powerful tool to establish a profitable mining business at the IPB and represents the most efficient and suitable solution to exploit polymetallic sulphides and extract maximum added value from the ores, producing commodities as final products.

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Outcomes produced in the comparative technical and economic study applied to traditional selective flotation process versus new hydrometallurgical processing of concentrates have given positive economic results: IRR above 15%. However, producing bulk concentrates and processing through hydrometallurgical way is much more profitable than obtaining selective concentrates: gathered IRR is 32% and NPV is 450 million USD; the pay-back time is 2 years. The attractiveness of these numbers is partly due to the incorporation of existing capital from the Las Cruces hydrometallurgical facility. Anyway, a green-field application would likely present similar positive results.

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Thank you very much for your attention.