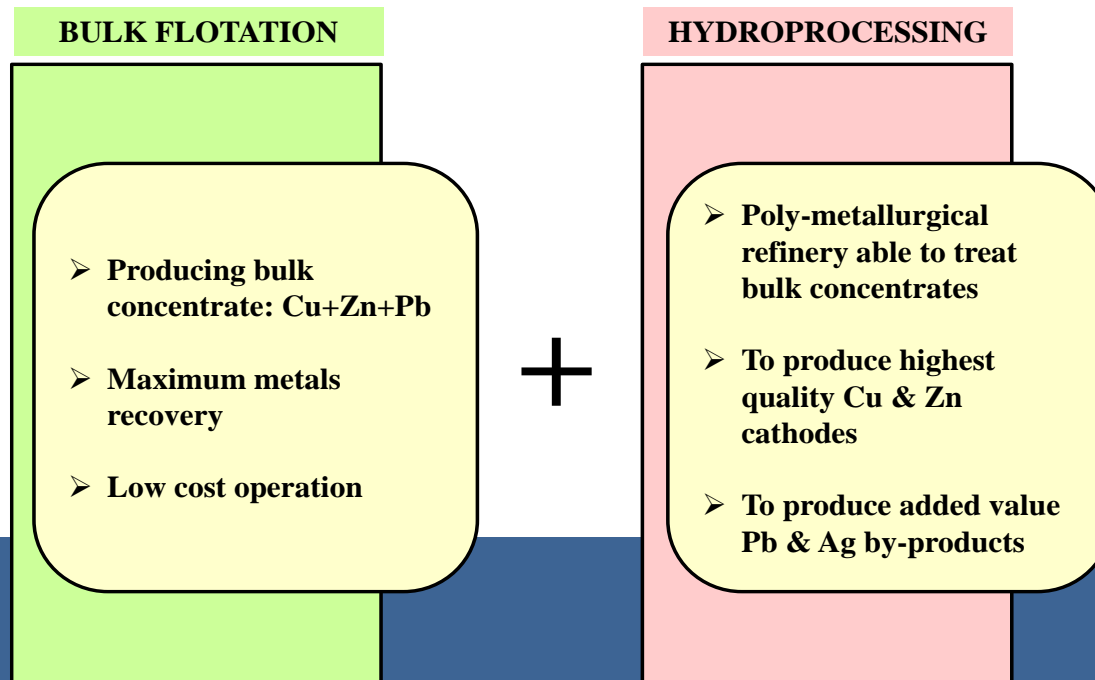


PMR PROJECT - Poly Metallurgical Refinery

- **The target.** To extend CLC life of mine and plant operations beyond 2030.
 - Processing primary massive sulphide ores and stockworks: Cu, Zn, Pb, Ag.
 - Developing a suitable hydrometallurgical solution: PMR technologies.
 - Producing in-situ refined metals (commodities): Mine-to-Metal concept.
- **The concept.** Integrated bulk concentrate flotation + hydroprocessing = **POLY METALLURGICAL REFINERY.**
 - Bulk flotation is simpler, cheaper, and allows to recover >90% of valuable metals.
 - Flexible hydrometallurgical technologies able to deal with low-grade and polymetallic bulk concentrates.



PMR PROJECT - Development

- **Pilot Plant.** PMR technologies were tested and validated in a pilot plant having a capacity of 1 t/h primary ores. Piloting comprises the following process stages:
 - Grinding and bulk concentrate flotation.
 - Atmospheric leaching of bulk concentrate to extract copper and zinc.
 - Chloride leaching of silver and lead from prior leach residue.
 - Silver and lead recovery as by-products or final products.



- Total operation: 5000 hours.
- Treated polymetallic ores: 4000 tonnes.

PMR PROJECT - Flotation Results

- **Bulk concentrate flotation.** Average results:
 - Flotation includes rougher stage, which tails are reground and fed to scavenger stage.
 - Rougher and scavenger concentrates are mixed as bulk concentrate and scavenger residue is the final tails.

Composition					
STEP	Weight, %	Zn, %	Pb, %	Cu, %	Ag, g/t
Feed	100	2.0	1.1	1.0	22
Rougher conc.	20.0	7.9	3.1	3.5	55
Scavenger conc.	15.0	2.4	1.7	1.3	35
Bulk conc.	35.0	5.5	2.5	2.5	46
Tails	65.0	0.18	0.31	0.14	9
Metals Distribution					
STEP		Zn, %	Pb, %	Cu, %	Ag, %
Rougher conc.		77.4	57.6	72.5	50.1
Scavenger conc.		17.6	23.7	20.2	23.9
Bulk conc.		94.3	81.3	90.6	73.3

PMR PROJECT - Leaching Results

- **Atmospheric leaching in ferric sulphate media.** Copper and zinc extraction. Average results:
 - Silver catalysed atmospheric leaching. Presence of silver promotes chalcopyrite leaching.
 - Silver is further recovered and recycled. No net consumption.

Average data					
Grade				d80 microns	Silver catalyst g/t
Cu (%)	Zn (%)	Pb (%)	Ag (ppm)		
Feed	1,8%	5,7%	4,3%	103	750
Tails	0,19%	0,54%	6,55%	1345	

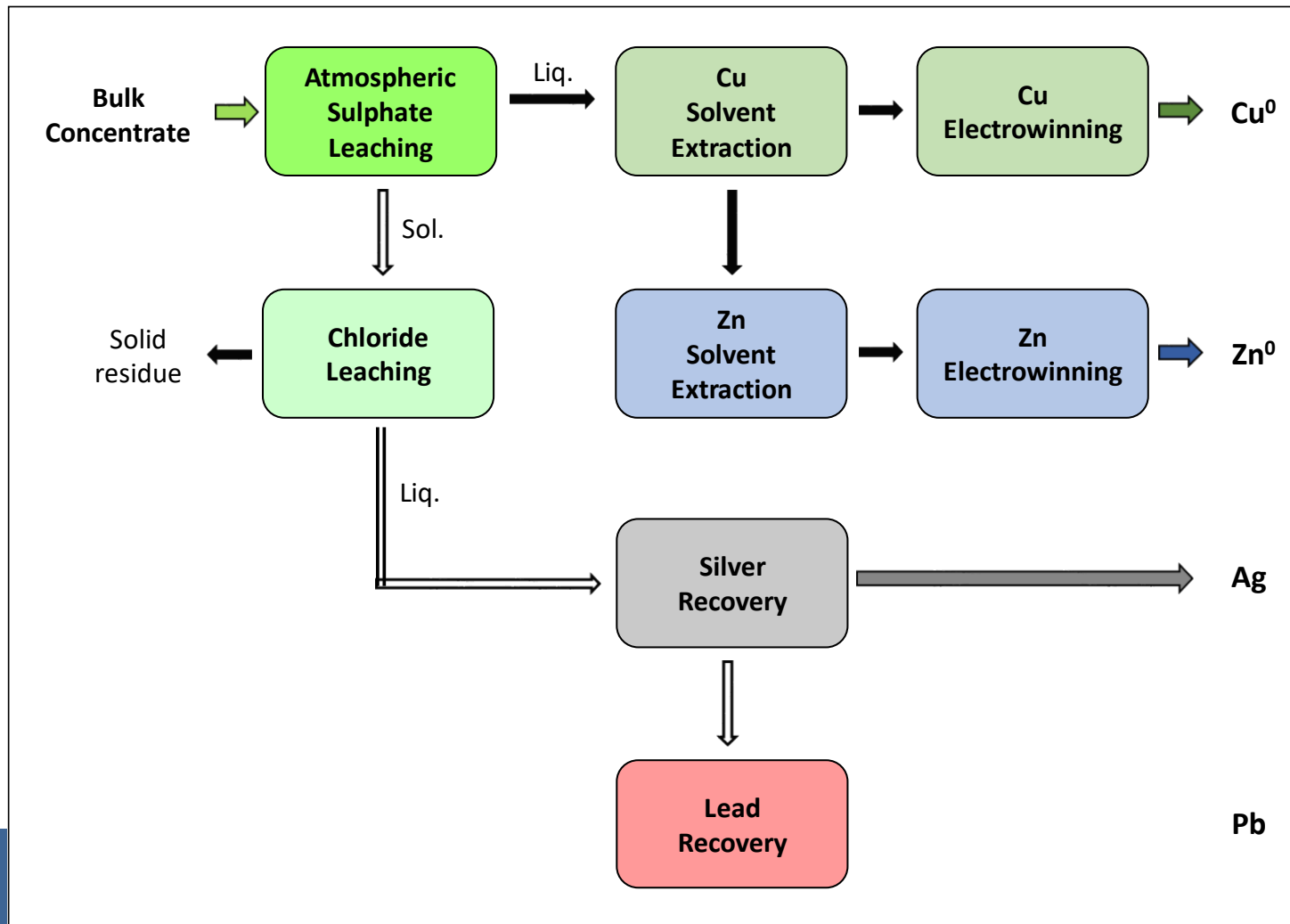
% dissolution			
Cu	Zn	Fe	Weight loss
93%	94%	36%	34%

- **Chloride leaching.** Silver and lead extraction. Average results:
 - Silver and lead are efficiently extracted in hot brine solution.
 - Silver is recovered by cementation and produced cement is recycled to prior leach process.

Hot Brine leaching					
Feed grade		% Dissolution			
		Average		Maximum	
Pb (%)	Ag (ppm)	Pb	Ag	Pb	Ag
6,15	1273	95%	96%	96%	97%

PMR PROJECT - Flowsheet

- PMR flowsheet. Integrated hydrometallurgical technologies. Mine-to-Metal concept:



PMR PROJECT - Remarks

■ **PMR technologies:**

- Developed PMR technologies have been tested and validated upon the pilot plant results achieved.
- It is advisable the potentiality of developed hydrometallurgical technologies to deal efficiently with low grade bulk concentrates.
- Copper and zinc leaching efficiency is very high, demonstrating silver catalyst process able to leach chalcopyrite at ambient pressure.
- Lead and silver leaching rate is very efficient.
- Silver and lead recovery is flexible and adapted to yield silver metal and lead by-product e.g. carbonate or lead metal production.

■ **Advantages versus conventional processing:**

- To increase 30-50% overall metals recovery thanks to bulk flotation.
- To process low-grade and complex ores (e.g. containing impurities such as Hg, Sb, As, etc.) that is unviable or uneconomic by traditional way.
- To produce in-situ refined metals (commodities).
- To recover additionally some critical materials (e.g. In, Co, etc.).
- To rise mineral reserves, reducing the cut-off, thanks to produce low-grade concentrates or bulk concentrates and increasing overall metals extraction.
- To achieve a more robust and sustainable mining business.
- Potentiality to be applied to other mines in the Iberian Pyrite Belt.