

# ION4RAW: Improving metal recovery in Cu-Pb-Zn- (Au-Ag) ore deposits through inventory of by- products and critical raw materials

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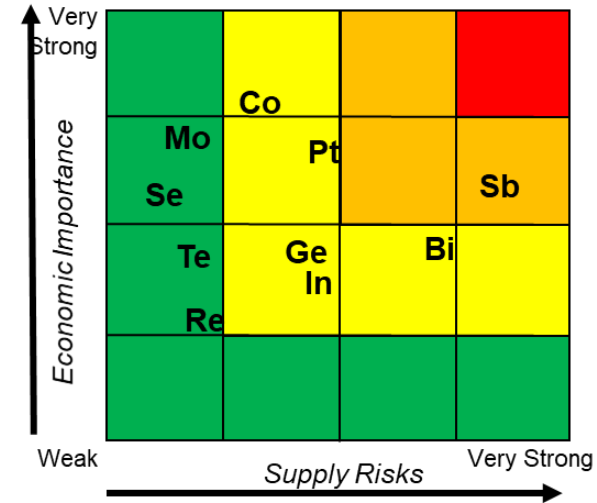
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# Introduction

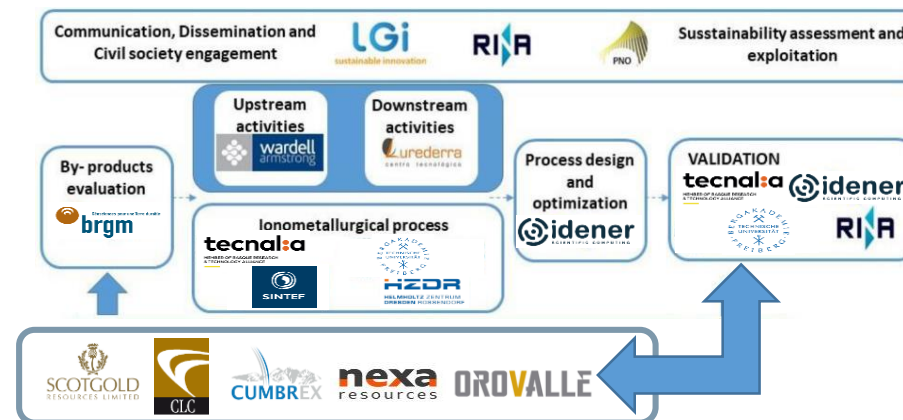
H2020 European ION4RAW project: Ionometallurgy of primary sources for an enhanced raw materials recovery

Improve recovery of by-products and CRM during ore treatment processes

- Obtain reliable estimates of by-products and CRM
- develop ionometallurgy processes
- 5 selected Cu-Ag-Au ore deposits through the world: Cononish Gold mine, Scotland; Cobre Las Cruces and El Valle Boinas, Spain; **El Porvenir** and Cerro Lindo, Peru



Coordinator : idener



ION4RAW project organization

**ION4RAW**  
Ionometallurgy of primary sources for an enhanced raw materials recovery

## Workpackage 2 (BRGM leader): inventory of by-products and CRM

➤ Characterization of ores and gangue, using a multi-technical approach

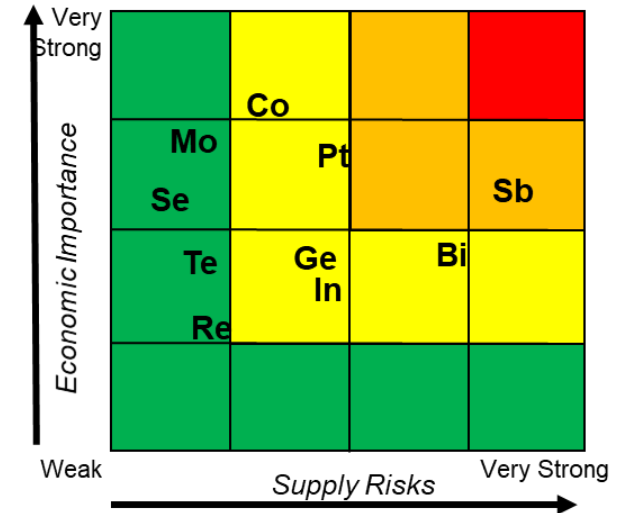
- XRD, bulk chemistry
- micro-XRF elemental mapping
- Optical and scanning electron microscope
- Electron microprobe (d.l. few 100 ppm)
- Laser-Ablation coupled with ICP-MS (d.l. 0.1 to few ppm)



Identify carrier minerals of CRM and by-products, determine their distribution



CRM and by-product quantification



# El Porvenir ore deposit (Mining operator: Nexa Resources)

## Location

Western Cordillera of the Andes mountain range in central Peru

## Ore type

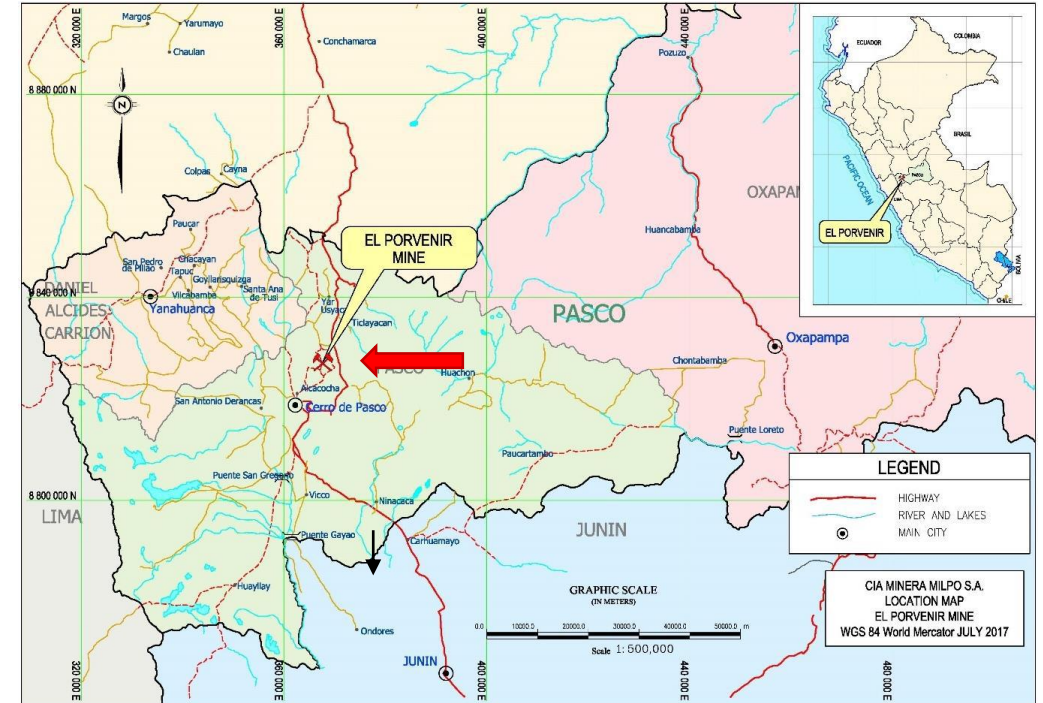
- Intrusive-related skarn
- Andradite-type garnet (Grt) and diopside-type clinopyroxene (CPX) exoskarns → calcic skarn group

## Main ore

- **Zn-Ag-Pb- (Au-Cu) polymetallic mineralization**
- **hosted by the andradite exoskarn**
- associated with the retrograde hydrothermal stage:  
**Mn-calcite, quartz**

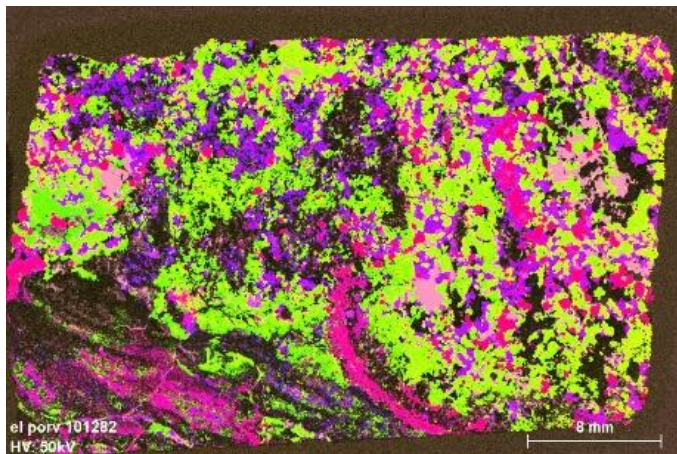
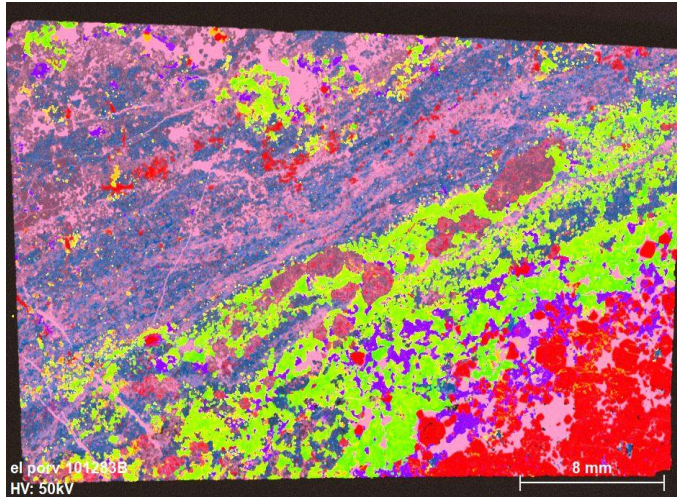
## Minor ore

- **Cu-Mo porphyry style**

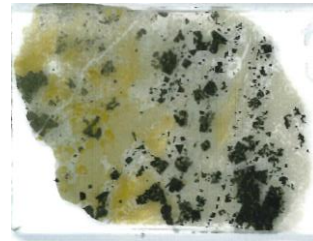


# El Porvenir ore characterization: Metal carrier minerals and their distribution

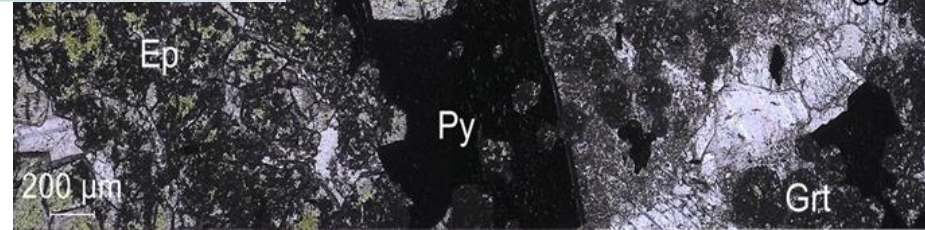
μXRF mapping (resolution 40 μm)



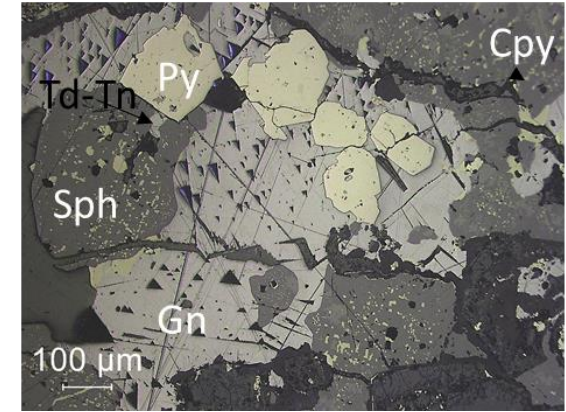
Sph  
Gn  
Py/ Py  
Mn-Cc  
Cpy



Andradite exoskarn



Ore minerals



Sphalerite: **Zn**, Cu, Ag, *Co*, *In (257 ppm)*, *Se*

Galena: **Pb**, Ag<sub>(0.3-1.5%)</sub>-Bi<sub>(0.1-3.5%)</sub>, *Sb (1325 ppm)*, *Se (234 ppm)*, *Te (876 ppm)*, *Rh*

Chalcopyrite: **Cu**, Ag, *Bi*, *In (115 ppm)*, *Ni*, *Pb*, *Pd*, *Rh*, *Sb*, *Se*

Tetrahedrite-tennantite **Sb (1-21%)**, **Cu**, **Ag (0.3-12.7%)**, *Bi (0.5%)*, *Se*

Pyrite *Au*, *Co*, *Ni*, *Pb*, *Sb*, *Se*, *Te*, *Zn*

Aleksite

Saddlebackite



**Bold:** main metal  
**Bold :** > 1 %  
Normal: > few 100 ppm (EPMA)  
*Italic:* > 1 ppm (LA-ICPMS)

Abbreviations: Py pyrite, Ep epidote, Chl chlorite, Sid siderite, Cc calcite, Qz quartz, Sph sphalerite, Cpy chalcopyrite, Po pyrrhotite, Born bornite, Gn galena, Td tetrahedrite, Tn tennantite, Kfs K-feldspar, Mus muscovite, Mo molybdenite

## ION4RAW WP2 - Conclusion and perspectives

- Optimize the multi-disciplinary approach of ore characterization to obtain reliable estimates of by-products and CRM, and apply it on the 5 ore deposits
- This presentation: El Porvenir ore deposit:
  - Zn-Ag-Pb-(Au-Cu) with low Au in pyrite
  - Galena main carrier of Ag but also Bi, Se, Sb, Te
  - low Mo associated with Cu-Mo porphyry mineralization
- monitore the by-products identified in ore to improve their recovery by ionometallurgy processes in the different concentrates

