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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Long-term management of the mineral resource supply incorporating anthropogenic environmental impacts is crucial for sustaining human society. This is especially true for recovery of by-products and critical raw materials (CRM) whose production is often unable to respond quickly to rapid changes in consumption trends. As part of European H2020 research and innovation, the ION4RAW project aims at obtaining reliable estimates of by-products and CRM, and at developing ionometallurgy processes to improve their extraction from primary resources. Targeted metals are by-products (Te, Se, Re and Mo) and CRM (Bi, Ge, In, Co, Pt, Sb) in 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). The final objective of this study is to determine the carrier minerals of CRM and by-products, the variability of their chemistry, their distribution and quantification, in order to improve their recovery during ore treatment processes. We currently inventory by-products and CRM by characterizing ores and gangue, using a multi-technical approach (bulk chemistry and X-Ray diffraction, optical and scanning electron microscopic observations, µX-ray fluorescence mapping, EPMA spot analyses and laser ablation-ICP-MS). We present here the preliminary results of El Porvenir and El Valle Boinas that are two calcic skarn-related deposits defined by their garnet composition.

El Porvenir (Peru), owned by Nexa Resources, is a Pb-Zn ore deposit associated with andradite–bearing skarn, exploited in an underground mine located in the Western Cordillera of the Andes mountain range in central Peru.
El Valle-Boinas (Spain), owned by Orvana Minerals Corp, is a Cu-Au ore deposit associated with a grossular-bearing skarn, exploited in an underground mine located in Cantabrian Mountains, 60 km southwest from Aviles in Spain.

Mineralogical investigations indicate that the major ore consists of chalcopyrite, galena, sphalerite, pyrite with minor pyrrhotite, tennantite-tetrahedrite–series minerals and tellurides. The electron microprobe allows analyzing micron-sized metal-carrier minerals, including electrum, Bi-Pb sulfosalts, hessite [Ag2Te], stannoidite, determining the composition of tennantite-tetrahedrite-series minerals (argentotennantite containing up to 12 wt% Ag and 5 wt% Bi) and detecting traces in major ore at a detection limits of 200-1000 ppm (for example, galena significantly contains Ag, Sb and Te). The laser ablation-ICP-MS was tested at maximum power of the laser and at different beam diameters adapted to the grain sizes (from 85 to 10 µm). Laser ablation-ICP-MS analyses with a beam diameter of 10 µm confirms EPMA data and allows detecting lower metal contents, such as Se, Rh, Pd, In, Te, in main ore minerals at detection limits of the ppm.