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Long-term management of mineral resource supply, incorporating anthropogenic environmental impacts, is crucial for sustaining human society. As part of the European H2020 research and innovation program, the ION4RAW project aims at obtaining reliable assessment of by-products and critical raw materials (CRM) and at developing ionometallurgy processes to improve their extraction from primary resources.

For the inventory of by-products and CRM, we currently develop the analyse of trace elements by laser ablation-ICP-MS on ore and gangue, combined with electron microprobe and µX-ray fluorescence mapping. The final objectives of this study are to determine the carrier minerals, to define the variability of their chemistry, to characterize their distribution and related quantification, in order to improve the CRM and by-products recovery during the ore treatment processes.

We present here the preliminary mineralogical and chemical characterization of a skarn mineralization from the El Porvenir Zn-Ag-Pb-(Au-Cu) ore deposit (owned by Nexa Resources) located in the Western Cordillera of the Andes mountain range, central Peru.

Mineralogical investigations, including µ-XRF mapping, indicate that the ore consists of sphalerite, galena, chalcopyrite, pyrite with minor tennantite-tetrahedrite–series minerals, pyrrhotite, tellurides, molybdenite, gold in a gangue composed of garnet, clinopyroxene, amphibole, micas, carbonate, quartz and K-feldspar with minor minerals such as titanite, apatite and fluorite.

The electron microprobe allows analyzing micron-sized metal-carrier minerals, including electrum, Bi-Pb sulfosalts, hessite [Ag2Te], determining the composition of tennantite-tetrahedrite-series minerals (from argentotennantite containing up to 12 wt.% Ag and 5 wt.% Bi to tetrahedrite) and detecting traces in major ore at detection limits of 200-1000 ppm (for example, galena significantly contains Ag, Bi, Sb and Te). Analyses of silicates allow precising the compositions of garnet, clinopyroxene, micas and minor minerals, as exemplified by grandite solid solution (from pure andradite to andradite 15-grossular 85), diopside, F-bearing phlogopite, Ba-muscovite present in different zones of the skarn.

The laser ablation-ICP-MS is applied on sulfide minerals and in-house developed sulfide standards at maximum power of the laser and at various beam diameters adapted to the grain sizes (from 85 to 10 µm). Laser ablation-ICP-MS analyses confirm electron microprobe data and allows detecting lower metal contents, such as Ag, Bi, Se, Rh, Pd, In, Te, in major ore at detection limits of the ppm with a beam diameter of 10 µm and at detection limits of 10 ppb with a beam diameter of 85 µm.