Unveiling new resources of high technological critical metals in hydrothermal pyrite and pyritic mine residues from VMS of the Iberian Pyrite Belt (SW Spain)

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The Iberian Pyrite Belt (IPB), in southwestern part of the Iberian Peninsula is one of the Earth’s largest metallogenic provinces. Extending about 250 km from Sevilla and Huelva provinces, in SW Spain, to Beja in Portugal, it groups, within a belt of 40-60 km, about 90 volcanogenic massive sulfide (VMS) deposits of polymetallic nature (Cu, Pb and Zn) with untapped resources of high technological critical metals hidden in both primary ores and related in situ waste material. A careful study of the geochemistry and mineralogy of pyrite (by means of EPMA, LA-ICP-MS, FE-SEM, EBSD and FIB-HRTEM) from polymetallic massive lenses and stockwork ores from various deposits show contrasting values of high technological critical metals. Pyrite (Py-1) crystallized at earliest stage of VMS deposit formation is rich in some High-Tech critical metals like Pb, Zn, and Sb, mostly hosted as nano-to-micron-sized particles of galena and tetrahedrite. In contrast, recrystallized pyrites affected by higher temperature hydrothermal overprint, showing spongy-looking (Py-2) or homogenous (Py-3) cores surrounded by external facets, are depleted in most High-Tech critical metals, expecting Au and Bi Cu, Ag, Co and Ni. Application of same methodological approach to pyritic wastes nearby the VMS deposits show also remarkable concentrations Au, Ag, Pb, Zn and Cu. This is the first ever estimation for the revalorization and reclassification of pyrite and their mining residues as possible new resource of technological metals in the Iberian Pyrite Belt. Our results show that both primary and secondary sources are amenable for exploitation and recovery of metals necessary for the clean energy transition.