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Critical element resource potential of mill tailings, Namib Pb-Zn mine, Namibia

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Mine waste repositories offer opportunities for reprocessing and extraction of previously discarded materials. The aim of this study was to establish the reprocessing potential of an abandoned tailings dump (4.0 Mm³) of the historic Namib Pb-Zn mine, which is situated east of Swakopmund in the Erongo Region of Namibia. Geochemical analyses of the sulphidic waste material were conducted using a hand-held XRF analyzer (pXRF) and laboratory analyses (XRD, ICP-MS). Such analytical protocols revealed within the sampled materials strongly elevated concentrations of base and precious metals (up to 5.69 wt% Pb, 9.57 wt% Zn, 1479 ppm Cu, 83 ppm Ag), critical elements (up to 46 ppm Bi, 40 ppm In, 43 ppm Sb, 40 ppm Sn, 66 ppm W), and environmentally significant elements (up to 587 ppm As, 399 ppm Cd). The tailings sulphide mineralogy is dominated by sphalerite and galena plus minor amounts of pyrite, pyrrhotite, graphite, arsenopyrite and marcasite in a calcareous matrix. Gangue minerals include goethite, lepidocrocite, gypsum, montmorillonite, biotite and quartz. Correlation coefficients of geochemical data indicate distinct In-Cd-Zn, In-Pb, Sb-Pb-Zn and Bi-As associations. Such positive correlations likely reflect the fact that the critical elements In, Sb and Bi are contained by sulphide minerals (e.g. sphalerite, galena, arsenopyrite). The data facilitate informed decisions on the reprocessing potential of the Namib tailings, including the possible recovery of critical elements from these wastes.