

Germanium enrichment and mineralogical hosts in ore and mine waste; primary and potential secondary sources

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Germanium, a critical element with limited supply and rising demand, is extracted as a byproduct during Zn sulfide ore processing. Our goal is to better understand processes that enrich Ge and determine its mineralogical hosts in ore, tailings, residues, and slag to evaluate potential for recovery. Analyses of sphalerite, the main Zn host mineral of Ge, reach over 1000 mg kg⁻¹ Ge from two Ge-recovering Zn mining regions in the U.S.; Ge and Cu concentrations are positively correlated, providing insight into enrichment. Mine wastes are potential secondary sources of Ge. However, during flotation there is nearly total reporting of Ge to the Zn concentrate because of its predominant presence in sphalerite. This results in tailings with low concentrations of Ge; tailings from six Zn or Pb-Zn deposits in North America contain less than 18 mg kg⁻¹ Ge. Following flotation, Zn concentrates are processed by either hydrometallurgy or pyrometallurgy methods. During hydrometallurgical processing at one U.S. Ge-recovering facility, nearly all the Ge ends up in Fe-rich residues that contain ~0.5 wt. % Ge. However, few Zn operations recover the Ge from these residues. Slag from pyrometallurgical processing may be a potential repository of Ge. Zinc slag from one historical U.S. site contains up to 70 mg kg⁻¹ Ge; other base metal slags contain up to several hundred mg kg⁻¹. Germanium speciation in mine wastes is critical to determining the feasibility for recovery. As an example, weathering of historical waste in one U.S. district has resulted in most Ge being hosted in a hydrated zinc silicate, which may be more amenable to leaching than sphalerite.