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Supergene Zn-dolomite: an old-new actor on the nonsulphide ore scene

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The supergene zinc and lead nonsulphide ores result from the weathering of original sulphide-bearing deposits (SEDEX, MVT and CRD), whose host rocks are mainly carbonates. Until now, the best-known interaction between the sulphide-hosting carbonate rocks and supergene fluids was limited to the exchange between the host rocks and the Zn and Pb ions carried in the fluids, commonly resulting in the precipitation of smithsonite, hydrozincite, cerussite and hemimorphite (Hitzman et al., 2003).
However, during our research in the nonsulphide mining districts of Jabali (Yemen), Yanque (Peru) and Southwest Sardinia (Italy), we could detect an unexpected widespread replacement of the host dolomites by newly formed zincian dolomite phases. The zincian dolomites from these mining districts are extensively distributed around the main deposits, and replace the predecessor dolomite phases. Their characteristics, which include the presence of variable amounts of Zn, Pb and Cd in the crystal lattice, are quite similar in all the investigated districts. The precipitation of Zn-dolomites is commonly followed by several Fe- and Mn(hydr)oxide phases and, eventually, by sparry calcite and/or (Mg-)smithsonite. From the paragenesis observed in many samples, we envisage the replacement of the dolomite host as a supergene multi-step process, starting with a progressive “zincification” of the dolomite crystals controlled by microfractures, followed by a patchy dedolomitization (resulting in the formation of calcite + Fe-Mn(hydr)oxides), and then eventually concluded by the complete substitution of dolomite by smithsonite. Part of the magnesium derived from the dolomite replacement is hosted in zoned smithsonite concretions. On the base of textural evidence, we interpret the Zn-dolomite phases occurring in the supergene zone of sulphide zinc deposits as the “missing link” between dolomite and smithsonite in the wall-rock replacement process.
The precipitation temperature of this Zn-dolomite at the respective localities should approach the local temperature of the meteoric fluids during the main weathering periods, when the sulfide deposits were oxidized. This temperature for SW Sardinia was determined to lie within a 11-23 °C interval by Gilg et al. (2008), using the O-isotope ratios of smithsonites and the estimated compositions of local paleometeoric waters. It is highly probable that this temperature interval would also be similar for the waters circulating in the other mining districts.
The ample extent of these replacement bodies of zincian dolomite in several mining districts, underestimated so far, is important for the exploration of nonsulphide zinc ores, because Zn-dolomite currently represents a non-economically recoverable phase. This may lead to an incorrect evaluation of the extractable metallic resources calculated from the assay data, and from non-specific mineralogical analyses.

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Hitzman, M.W., Reynolds, N.A., Sangster, D.F., Allen, C.R., and Carman, C.E., 2003, Classification, genesis, and exploration guides for nonsulfide Zinc deposits. Economic Geology and the Bulletin of the Society of Economic Geologists, v. 98, p. 685–714.