American Mineralogist, Volume 110, pages 582–593, 2025

Macro- to nanoscale investigation unlocks gold and silver enrichment by lead-bismuth metallic melts in the Switchback epithermal deposit, southern Mexico

Néstor Cano[1,2,*], José María González-Jiménez[3], Antoni Camprubí[1,2], Joaquín A. Proenza[4], and Eduardo González-Partida[5]

[1]Instituto de Geología, Universidad Nacional Autónoma de México (UNAM), Ciudad Universitaria, 04510 Coyoacán, CDMX, Mexico
[2]Laboratorio Nacional de Geoquímica y Mineralogía (LANGEM) UNAM, Ciudad Universitaria, 04510 Coyoacán, CDMX, Mexico
[3]Instituto Andaluz de Ciencias de la Tierra (IACT-CSIC), Avda. de las Palmeras 4, 18100 Armilla, Granada, Spain
[4]Departament de Mineralogia, Petrologia i Geologia Aplicada, Facultat de Ciències de la Terra, Universitat de Barcelona, Martí i Franquès s/n, 08028 Barcelona, Catalonia, Spain
[5]Instituto de Geociencias, Universidad Nacional Autónoma de México, Blvd. Juriquilla 3001, 76230 Juriquilla, Qro., Mexico

Abstract

Lead-bismuth (Pb-Bi) minerals of the galena (PbS)-matildite ($AgBiS_2$) series and lillianite homologs ($Pb_{3-2x}Ag_xBi_{2+x}S_6$) are intergrown with electrum (Au-Ag alloy) and chalcopyrite ($CuFeS_2$) in specific bands within a colloform-banded vein at the Switchback epithermal deposit in southern Mexico. A macro- to nanoscale study revealed that these minerals fill small (<200 μm) cavities in the gangue minerals, showing curvilinear boundaries, bleb-like morphologies, and rounded nanoparticles (~100 nm). These observations are consistent with growth in a molten system from a precursor Pb-Bi melt containing Au, Ag, and Cu. Minerals in the galena-matildite series typically display Widmanstätten textures (i.e., octahedral-like or basket-weave matildite$_{ss}$ lamellae in the galena$_{ss}$ matrix), which have been traditionally linked to the decomposition of a high-temperature solid solution. However, galena$_{ss}$ and matildite$_{ss}$ show nanoscale sinuous reaction fronts and replacement relicts ("islands") while maintaining the $[011]_{Galena} \parallel [100]_{Matildite}$ crystallographic orientation relationship. This suggests a topotaxial growth of matildite$_{ss}$ mediated by coupled dissolution-reprecipitation reactions between galena$_{ss}$ and the metallic melt upon cooling. A similar scenario is proposed for Pb-Bi sulfosalt intergrowths, which replace galena-matildite and electrum and grow topotaxially along $(200)_{Galena}$. Collectively, these results suggest that Pb-Bi melts can exist in epithermal fluids, acting as precursors for the crystallization of ore minerals and being able to sequester precious metals. This model explains abnormally high-Au-Ag enrichments observed in some deposits that contain Pb-Bi ores.

Keywords: Epitaxial, topotaxial, galena-matildite, electrum, Pb-Bi sulfosalt, Sierra Madre del Sur, Mexico