Rare metal concentration triggered by sulfide dynamic recrystallization

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ABSTRACT

Rare metals are essential to the development of the green technologies at the core of an emerging low-carbon society (Vidal et al., 2013). Germanium, Ga or In occur in trace concentrations in numerous base-metal ore deposits, but processes responsible for their concentration into economically valuable ores are poorly understood. Here we show that syn-tectonic recrystallization of Zn sulfide triggers to the hyper-concentration of Ge from background levels of a few hundred ppm in primary sphalerite (ZnS) to tens of weight percent in accessory Ge-minerals.

In this study we present maps of mineral microstructures acquired using electron backscattered diffraction, associated to laser-induced breakdown spectroscopy chemical mapping, and *in situ* chemical analyses (electron probe microanalysis and laser ablation inductively coupled plasma mass spectrometry) performed on naturally deformed Ge- and Ga-rich sphalerite from Pb-Zn deposits in the Variscan axial zone of the Pyrenees mountain belt (Cugerone et al., 2018a,b). These deformed vein-Type Pb-Zn deposits exhibit recrystallized sphalerite textures associated with important chemical heterogeneities in Ge and Cu contents. We propose that Ge-atoms were removed from the primary sphalerite crystal lattice during dynamic recrystallization and were subsequently concentrated to form Ge-minerals (Ge oxides, chloritoids and sulfides), leaving behind a Ge-depleted fine-grained recrystallized sphalerite matrix. We believe that this process of hyper-concentration of Ge may occur in most of Pb-Zn deposits that have undergone recrystallization worldwide (e.g. Mt Isa and Waterloo in Queensland, Mt Lyell in Tasmania).

Routine mineral prospection based on geochemical and geophysical bulk data screening would typically fail to locate this important resource. Understanding how rare metals can become concentrated through dynamic recrystallization has major implications for Ge and related rare metal exploration. We suggest that exploration methods must integrate detailed structural field observations as well as textural and microstructural information, as suggested almost half a century ago (Nixon et al., 1961), but subsequently largely ignored.

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