Mineral resources associated with shear zones in the Eastern Spanish Central System

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Abstract

Mineral resources are of great importance for the economy of a country and for the industrial and technological development of society. Understanding how mineral deposits are produced is crucial to their exploitation. Shear zones facilitate the formation of these reservoirs since they can be controlled by tensional stresses and are associated with the circulation of fluids. Therefore, understanding the geometry, relative timing and location of a shear zone is very important for the exploitation of mineral resources as these parameters, once established for a given area, can be used as a preliminary approach to design exploration campaigns in other areas that share similar geological evolution.

Our study has been carried out in Guadalajara (Spain), on a polydeformed metamorphic basement mainly structured during the Variscan Orogeny, in Carboniferous times. A second phase of deformation (D2) led to the development of a ductile shear zone. In the study area, several mines exploit gneisses of Hiendelaencina Formation (Hiendelaencina Mining District), largely strained within the D2 ductile shear zone. These gneisses contain silver ores, present in Sb-rich sulfosalts. The geological study of the area allows us to constrain the geometry and timing of this shear zone. In origin, the D2 shear zone was flat-lying, if slightly dipping to the SE, and conducted crustal attenuation. Superimposed deformation (D3) rotated D2 shear planes and associated foliation (S2) to define D3 upright folds. D2 deformation was accompanied by intense metamorphic recrystallization of previously (D1) deformed rocks to produce a penetrative (S2) foliation in footwall rocks, as well as partial melting and intrusion of granitoids into footwall rocks.

In addition, the Permian is a period of extensional tectonics in this area. Extension was coeval to the intrusion of intermediate composition magmatism (andesites). Permian extension generated brittle shear zones (faults) in which minerals with economic importance precipitated. Our structural analysis in the region has revealed that the subsequent Alpine Orogeny reactivated normal Permian faults as thrusts. The structure of mineral ores generated during Permian extension may not be explained by the functioning of normal faults alone, since inversion of these faults must have introduced further complexity to the ore distribution. Interestingly, previous works in the mining district failed to recognize the reactivation of these faults, what led to a misunderstanding of the distribution patterns within the ore district. To this figure, fluid and melt circulation related to the functioning of the Variscan extensional shear zones formed during D2, and the occurrence of sulfide ores exclusively in the sections where those processes were more intense, suggest a relationship between extension-related shear zones and ore-forming processes in the study area, thus complicating the recognition of the full picture of ore deposits in the mining district. A new reevaluation of the regional structure and its evolution along the different orogenic cycles that affected the mining district is advised in order to design future mining campaigns, whether they are focused on exploration and/or exploitation.