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

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Introduction and geological setting

The silver ore district of Hiendelaencina (Guadalajara) has been very important for the history of mining in Spain, and is found in the crystalline basement of Central Iberia (Fig. 1). Mineralizations occur in hydrothermal veins, within augen gneisses from the Hiendelaencina Formation. The veins with the highest ore grade have NE-SW strike [1].

Figure 1- Location of the study area.

Results and discussion

In this area, two phases of deformation related to extension are identified [2]:

Variscan extension

The metamorphic basement cut by the mineralized veins has been affected by three Variscan deformation phases in Carboniferous times. The second phase of deformation (D_2) led to the development of a ductile shear zone. In origin, the D_2 shear zone was flat-lying, if slightly dipping to the SE, and conducted crustal attenuation (Fig. 2). D_2 deformation was accompanied by intense metamorphic recrystallization of previously (D_1) deformed rocks to produce a penetrative (S_2) foliation in footwall rocks, as well as partial melting and intrusion of granitoids into footwall rocks. Superimposed deformation (D_3) rotated D_2 shear planes and associated foliation (S_2) to define D_3 upright folds.

Permian extension

Permian extension in the study area is evidenced by normal faults that affected the crystalline basement (Fig. 3, 4, 5) and by the development of strongly subsiding basins filled by alluvial fans [3]. Permian faults strike NE-SW and NNW-SSE. Permian extension was coeval to magmatism with intermediate composition (andesites), so fluid circulation along faults is expected. Our structural analysis in the region has revealed that the subsequent Alpine Orogeny reactivated normal Permian faults (Fig. 6).

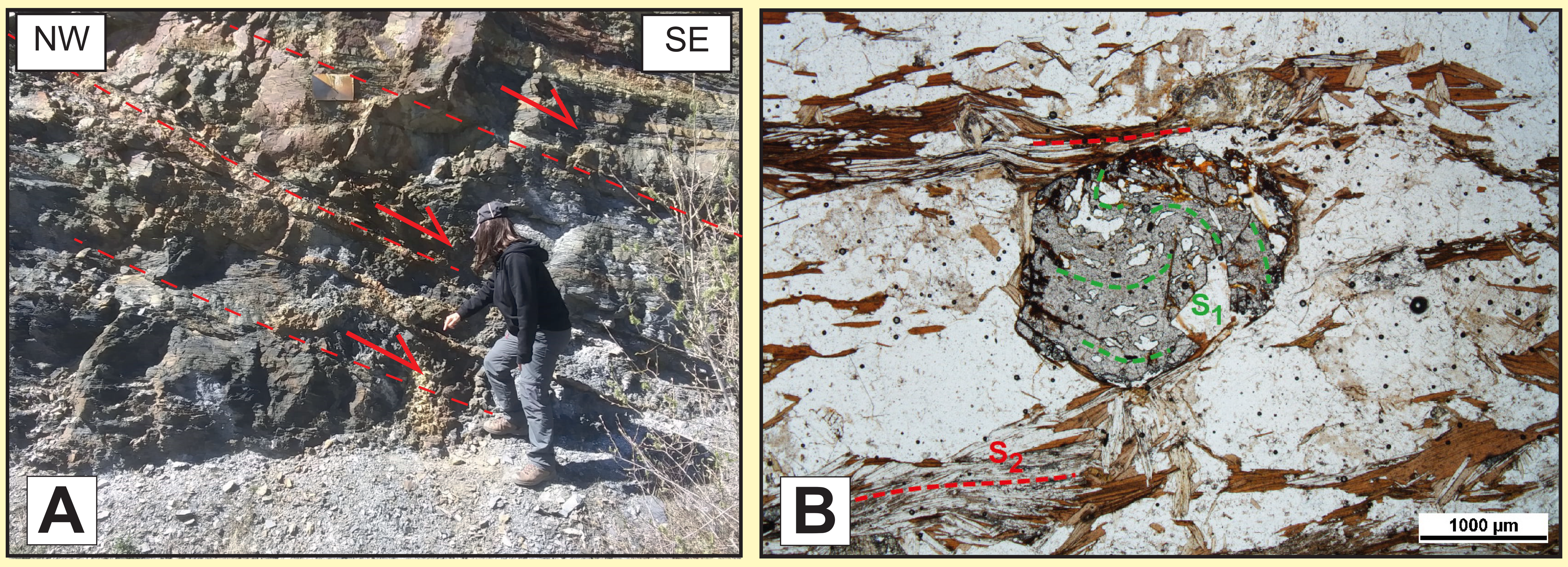

Figure 2- A: normal faults associated with D_2. B: Folded S_1 microinclusions in garnet porphyroblast grown during the development of S_2 in micaschists.

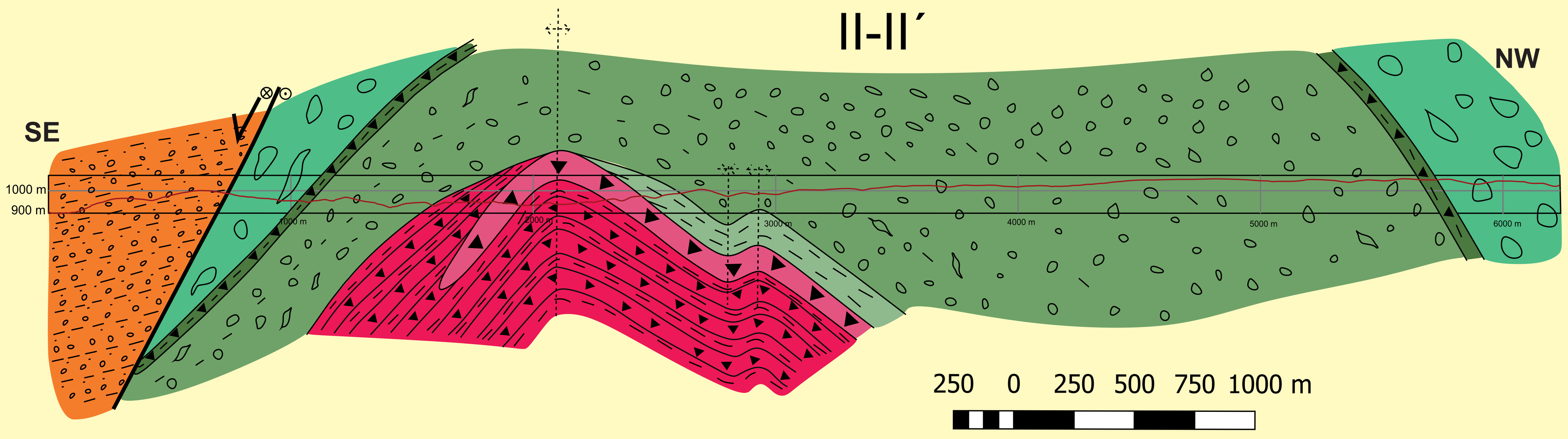

Figure 5- Cross section to normal Permian faults marked in black.

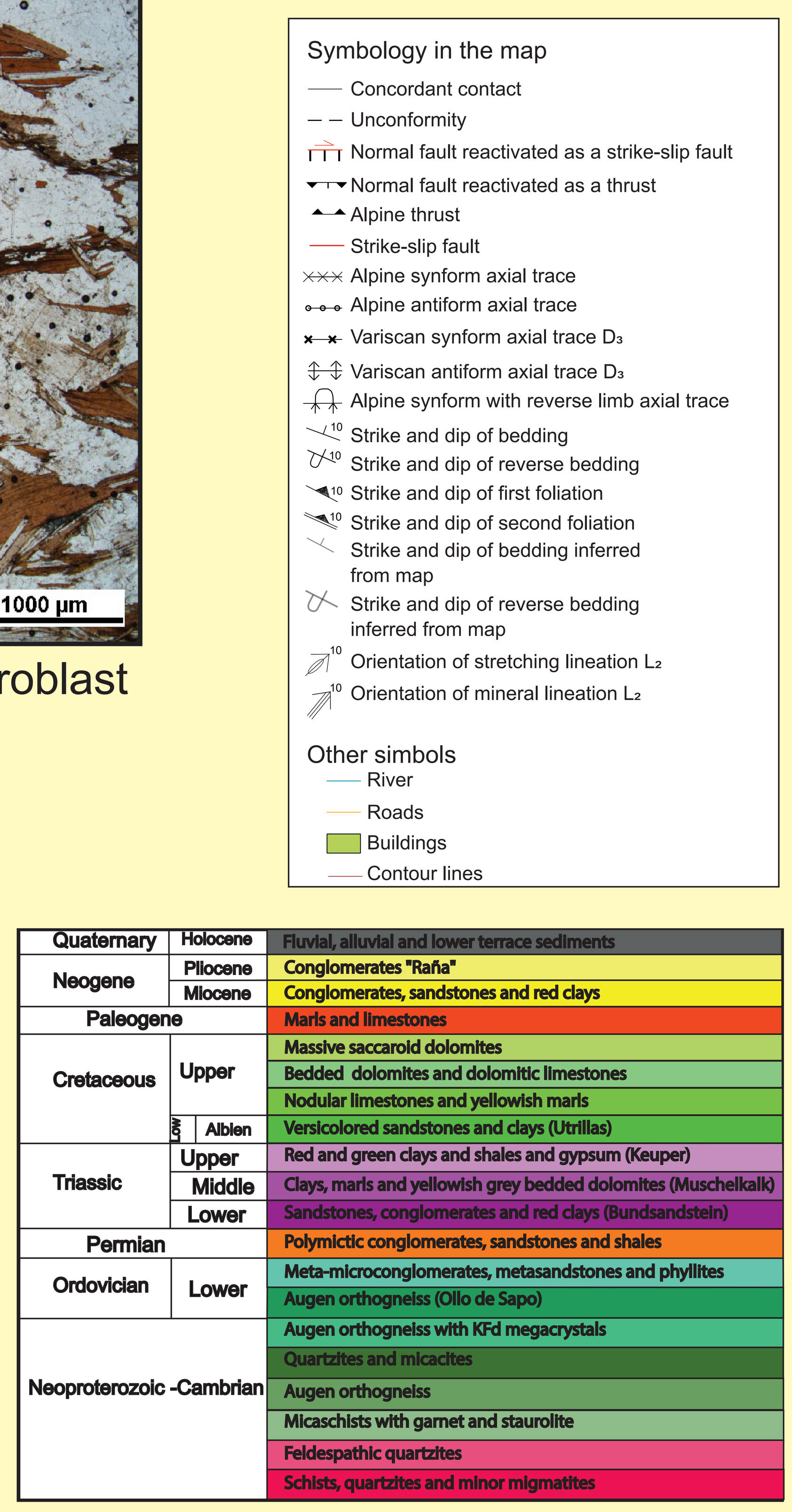

Figure 4- Map legend.

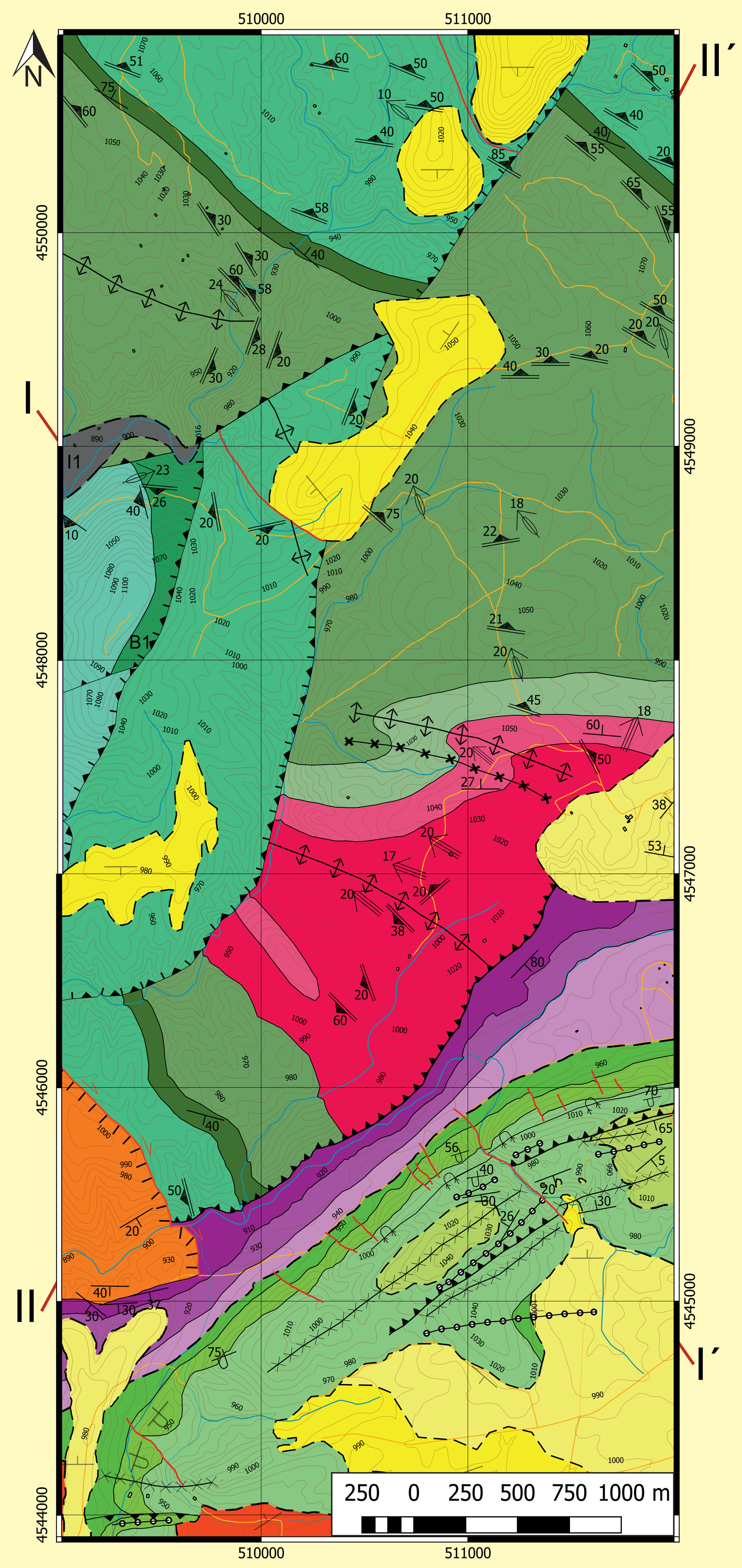

Figure 3- Map of the study area.

Structural control on silver ores

Previous works recognized that silver ores in the mining district of Hiendelaencina were preferentially located along NE-SW faults. Such strike is shared by D_2 Variscan and Permian faults alike. Both fault sets were generated in a time period featured by fluid circulation, so the ascription of the ores to one particular orogenic cycle is not straightforward and should not be based on structural data alone. For instance, all of the sites containing the higher ore grades are exclusively located in sections pervasively affected by D_2 ductile shearing, and evidence of Permian magmatism is yet to be found in those particular sites (Permian volcanics occur several kms to the North).

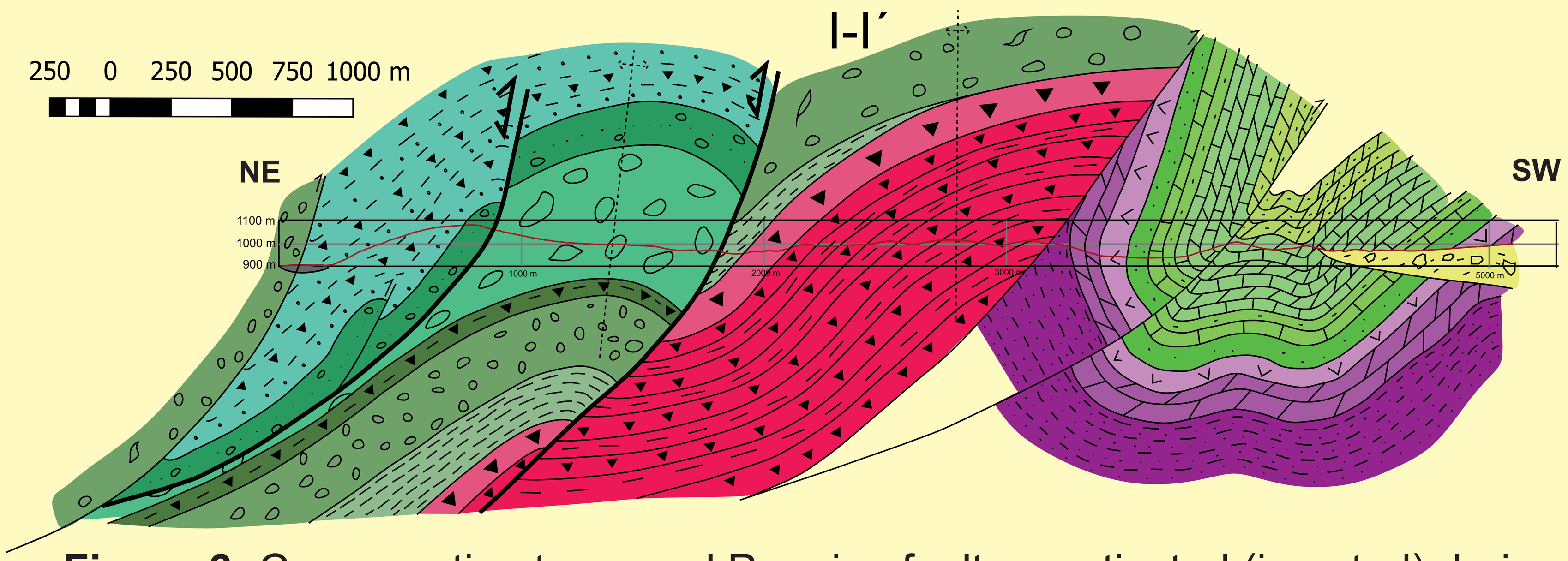

Figure 6- Cross section to normal Permian faults reactivated (inverted) during Alpine Orogeny. Present normal fault geometry.

Conclusions

Fluid and melt circulation related to the functioning of the Variscan extensional shear zones formed during the Variscan Orogeny and Permian period, along with 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. This complicates 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.

References:

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