Antimony quartz and antimony-gold quartz veins from northern Portugal

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In northern Portugal, there are two main areas containing antimony, lead-antimony and antimony-gold deposits. The antimony and lead-antimony quartz breccia veins from the Bragança district are mainly hosted by Silurian phyllites. The antimony-gold quartz breccia veins from the Dúrico-Beirã region are mainly hosted by the Cambrian schist-metagraywacke complex and also Ordovician phyllites and quartzites. These veins are up to 200 meters long, but their thickness ranges from a few centimeters to 3.6 m.

In each deposit, some minerals show multiple paragenetic settings, suggesting that mineral precipitation is a polyphase process. Arsenopyrite, pyrite and pyrrhotite are the earliest sulfides to form. The earliest generation of euhedral gold is earlier than or contemporaneous with arsenopyrite and earlier than pyrrhotite and pyrite. Berthierite and stibnite are the most important antimony-bearing minerals. Stibnite is most abundant. Later anhedral gold grains are present within fractures between arsenopyrite and stibnite and in stibnite, which is partially replaced by the gold. Gold inclusions rarely occur in quartz. Carbonates precipitated in the last hypogene stage.

The drastic fluid cooling during the mineralizing event was an important cause of mineralization. However, acidificaton of fluids might have been the main mechanism for stibnite precipitation, as it would have destabilized $Sb(OH)_3$. Gold associated with arsenopyrite, pyrite and quartz was probably carried as a bisulfide complex by the early aqueous carbonic fluid with 2 wt% eq. NaCl at 290-340^o C, while the late generation of gold associated with berthierite and stibnite was transported as a bisulfide complex by the H_2O-NaCl (2 wt% eq.) fluid at 128-225º C.

Variscan folding, long deep faults, shear zones, and deformation in the Bragança district and Dúrico-Beirã region would have provided anomalous crustal heat flow to sustain the extensive and long-lived hydrothermal activity. The metamorphic fluids derived from the country metasediments and heated meteoric water, which also leached metals from these metasediments, were responsible for the origin of the mineralized veins. The lead isotopic data for stibnite indicate a homogeneous source of lead of crustal origin, from a dominant metasedimentary source, for the studied antimony, lead-antimony and antimony-gold quartz veins. This is consistent with related European mineralizations.