Fluid inclusion study of Cu-rich deposits from the Sousel-Barrancos metallogenic belt (Ossa-Morena Zone, Portugal)

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The physical and chemical properties of mineralising fluids may provide important input for the metallogenic modelling of a particular deposit. The purpose of this study is to characterise the fluids involved with Cu mineralisation in the *Miguel Vacas* and *Moviços* ancient mines, as well as the *Ferrarias* occurrence, located in the Portuguese *Ossa-Morena* Zone (OMZ), in the denominated *Sousel-Barrancos* metallogenic belt (SBMB). These deposits are characterised by quartz + carbonate veins with main sulphide mineral assemblages of chalcopyrite + pyrite and bornite ± digenite in the supergene enrichment zone. In *Ferrarias*, sphalerite and galena were also identified, whereas arsenopyrite was found in the *Miguel Vacas* deposit. The evaluation of relative ages and spatial distribution of fluid inclusions is essential for establishing a metallogenic model for these Cu-rich deposits. Twenty bipolished thick sections were prepared from borehole and surface samples, and over 400 fluid inclusions (FI´s) were studied using microthermometry and Raman spectroscopy.

FI´s were classified regarding their composition as LVS_{1-3}, where L and V are H_2O, S_1 is halite, S_2 is a carbonate and S_3 is an opaque phase; Most of these inclusions contain a halite crystal. $L_{1-2}VS_{1-2}$, where L_1 is H_2O, L_2 and V are CO_2, S_1 is halite and S_2 is a carbonate or an opaque phase. $L_{1-2}V$, where L_1 is H_2O, L_2 and V are CO_2. LV consists of two-phase inclusions, where L and V are H_2O. Besides these fluids, several two-phase LV FI´s (where L and V are CO_2) were studied in deformed milky quartz, hosted in the metasedimentary units from the *Moviços* deposit.

The wide range of salinities [0.18 – 44.3; $\bar{x}$ = 17.6 wt%, NaCl equiv.] and homogenisation temperatures [62.8 – 420 ºC; $\bar{x}$ =211.3 ºC] found for the FI´s from these deposits reveal a two-stage fluid-circulation model. The data shows a high-salinity fluid with variable T_h values, along with a trend towards lower salinities, suggesting different sources for the fluids trapped. The presence of several daughter minerals such as Ca-Mg-carbonates and opaque minerals, combined with first ice melting temperatures ranging between -5 and -80 ºC ($\bar{x}$ = -39.3 ºC) suggest that high-temperature fluids were rich in solutes like NaCl, $MgCl_2$ and $CaCl_2$. The correlation between Cu mineral phases and carbonates suggests that these fluids may have been the carrier of Cu during mobilisation and deposition. CO_2-bearing FI´s microthermometry data (T_{mCO2}= [-60.5 ºC - -56.4 ºC; $\bar{x}$ = -57.5 ºC] and T_{hCO2}= [7.1 – 30.5 ºC; $\bar{x}$ = 20.4 ºC]) suggest that a magmatic source also provided some CO_2. Alternatively, CO_2 with minor CH_4 (< 5 mol%) may have formed by the devolatilisation of organic matter in the Paleozoic host rock.

FI data suggest that Cu mobilisation and precipitation was controlled by high-salinity fluids with variable CO_2 contents, which evolved to lower salinity fluids, due to mixing with meteoric water. The high-salinity fluids (LVS_{1-3}, $L_{1-2}VS_{1-2}$) show features that are comparable with those found in Cu deposits with a strong magmatic signature. Several plutonic to sub-volcanic calc-alkaline bodies near the SBMB (e.g. *Sta. Eulália* Plutonic Complex) are considered possible sources. These magmatic bodies suggest porphyry-like conditions during the geodynamic evolution of the OMZ (see also *Baleizão* porphyries). The FI´s may provide evidence for the presence of deep-seated magmatic intrusions related to Cu mineralisation in the SBMB, in fact, positive magnetic anomalies were found near the *Moviços* area (Silva et al., 2000) corroborating this hypothesis.

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