

THE Au-Ag ORES OF THE PINGÃO DOS QUINTAIS PROSPECT (FRANÇA AREA, BRAGANÇA, NE PORTUGAL)

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The Pingão dos Quintais prospect is one of four mining prospects in the França area, *circa* 15 km north of Bragança (NE Portugal). Mining activity in this prospect goes back to Antiquity, most probably to pre-Roman and Roman periods. Intermittent mining persisted, however, till 1951 and, between 1946-1951, the average Au ore grade was 7 g/ton (Burnay Bank, unpublished reports, 1911, 1913, 1948, 1952; Carvalho, 1979; Cathelineau *et al.*, 1993b). In 1988-89 some exploration work was carried out at the prospect by the joint venture CMP-Cercal-Prominas in order to re-evaluate its economic potential. Surface and underground geological mapping was performed, as well as an extensive geochemical program, along two main E-W galleries with a total length of 200 m. For the two galleries, an average Au content of 15 or 5 ppm was obtained, considering samples with 1 or 2.5 m width, respectively (vein thickness \approx 0.5 m).

The Pingão dos Quintais prospect is located in the Autochthon Domain of the Iberian Terrane where the superimposed effects of three Variscan phases of deformation (D1 – Upper Devonian, to D3 – Upper Carboniferous) are well characterized (*e.g.* Ribeiro *et al.*, 1990). Here a succession of quartzites interbedded with black schists (Arenigian - Llanvirnian) and slates with carbonaceous horizons (Llandeilian - Caradocian) can be recognized along the axial domains of first order D₁ folds with vergence towards the NE and axes oriented 10°, N50-55W (*e.g.* Meireles *et al.*, 1995). The S₁ axial plane foliation is penetrative and dips 40-50° towards the SW. In the slate sequence, S₁ is usually transposed and folded; the axes of D₂ kink bands and shear kink folds with SW vergence show gentle dips (< 25°) towards the ESE and strike from NW-SE to WNW-ESE; S₂, tilting 40° to 60° towards the N-NNE, strikes WNW-ESE to W-E. A late subvertical crenulation observed in several rock domains can be attributed to D₃. These metasedimentary sequences experienced regional low T-P metamorphism (chlorite facies conditions); mineral parageneses of high grade facies (biotite and andalusite zones) can be found near the syntectonic granites (Pereira *et al.*, 1984). Another important structural feature concerns the remarkable branching displayed by the Vilarica strike-slip fault zone (VFZ), bringing to contact the above Upper Ordovician units with graphite slates and lites of Silurian age (Llandoveryan).

Three main types of mineralized structures can be identified at the Pingão dos Quintais Prospect: (1) irregular N15-30W quartz-siderite veins, representing subsidiary structures of the VFZ; (2) discontinuous, N80-100E, 40-50S, en echelon quartz veins within a pre-existent N70-80W subvertical shear zone intersected by the VFZ; and (3) quartz breccias to be found within dilatant jogs of the VFZ. The cyclic deposition of the mineral parageneses, as well as their heterogeneous and polyphasic deformation, are common features, regardless of the type and development of the mineralized structure. Arsenopyrite, pyrite, and galena are the main sulphide minerals in the Au-Ag lodes, whereas the mineralogy of the gangue is largely domi-

nated by quartz and carbonates, although sericite and chlorite may be locally important. Deposition of Au-Ag alloys is a relatively late process, mostly postdating the growth of a second generation of (euhedral and finely zoned) arsenopyrite. Hydrothermal alteration of the host rocks, pre- and post-dating the brecciation and the opening of multistage veinlets, led to pervasive silicification and different degrees of sericitization and carbonatization with local dissemination of pyrite and sparse arsenopyrite.

Fluid inclusion data suggests that a progressive change in the bulk fluid composition has occurred from early metamorphic $H_2O-CO_2(-CH_4)$ fluids ($300\pm 10^\circ C$) to late H_2O -dominated solutions ($<180^\circ C$) of probable meteoric origin. According to the obtained P-T-t path, it is evident that a transition between relatively deep and shallow crustal levels (under pressures of 1 ± 0.2 and $0.2-0.4$ kbar, respectively) has occurred. Depressurisation of the system, induced by repeated seismic events at the VFZ, as well as the gradual inflow of (modified) meteoric aqueous solutions, justify the compositional variation admitted by the $H_2O-CO_2(-CH_4)$ fluids, as this variation can be explained either by dilution and/or by loss of volatile components. The period of Au-Ag alloys formation, related to the circulation of acid aqueous fluids of low salinity under $fO_2 > 10^{-35}$, clearly post-dates the major stages of sulphide-siderite deposition and fracturing, thus ascribable to the low-temperature hydrothermal activity coeval with the late deformation events in brittle regime.

The P-T-t path recorded by the Pingão dos Quintais ores is in good agreement with other independent data achieved for NW Iberia, strongly suggesting that the circulation of large volumes of hydrothermal fluids along the (reactivated) regional shear zones and strike-slip faults took place mainly after Westphalian times, being thus coeval with the moderate Late-Variscan crustal uplift (≈ 5 mm/y).

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