



As–(Ag) sulphide veins in the Spanish Central System: further evidence for a hydrothermal event of Permian age

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Abstract

The Spanish Central System (SCS) has been subjected to repeated deformation and fluid flow events which have produced both sulphide-bearing and barren vein systems. Although several hydrothermal episodes took place between 300 and 100 Ma, fluid circulation during the Permian was especially important, giving rise to a range of different types of deposits. This study presents a multidisciplinary approach leading to the characterisation of the chemistry and age of the hydrothermal fluids that produced the As–(Ag) mineralised stockwork of Mónica mine (Bustaviejo, Madrid). Fluid inclusion data indicate the presence of two different fluids. An initial ore stage (I) formed from a low- to moderate salinity (3–8 wt.% eq. NaCl) H₂O–NaCl–CO₂–CH₄ fluid, at minimum trapping temperature of 350 ± 15 °C and 0.3 kbar. A second H₂O–NaCl fluid is found in three types of fluid inclusions: a high temperature and low salinity type (340 ± 20 °C; 0.8–3.1 wt.% eq. NaCl) also associated to ore stage I, a moderate temperature and very low salinity type (160–255 °C; 0–1.5 wt.% eq. NaCl) represented in ore stage III, and a very low temperature and hypersaline type (60–70 °C; 30–35 wt.% NaCl), unrelated to the mineralising stages and clearly postdating the previous types. ⁴⁰Ar–³⁹Ar dating on muscovite from the early As–Fe stage (I) has provided an age of 286 ± 4 Ma, synchronous with the late emplacement phases of La Cabrera plutonic massif (288 ± 5 Ma) and with other Permian hydrothermal events like Sn–W skarns and W–(Sn) sulphide veins. δ¹⁸O of water in equilibrium with stage I quartz (5.3–7.7‰), δD of water in equilibrium with coexisting muscovite (–16.0‰ to –2.0‰), and sulphide δ³⁴S (1.5–3.6‰) values are compatible with waters that leached metamorphic rocks. The dominant mechanism of the As–(Ag) deposition was mixing and dilution processes between aqueous–carbonic and aqueous fluids for stage I (As–Fe), and nearly isobaric cooling processes for stages II (Zn–Cu–Sn) and III (Pb–Ag). The origin and hydrothermal evolution of As–(Ag) veins is comparable to other hydrothermal Permian events in the Spanish Central System.

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1. Introduction

Episodic hydrothermal events, ranging from the Variscan orogeny to the present day, have been recog-

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