ELSEVIER

Marine and Petroleum Geology 19 (2002) 323–337

Marine and Petroleum Geology

www.elsevier.com/locate/marpetgeo

The latest Post-Variscan fluids in the Spanish Central System: evidence from fluid inclusion and stable isotope data

Tomás Martín Crespo[a,*], Antonio Delgado[b,1], Elena Vindel Catena[a], José Angel López García[a], Cécile Fabre[c]

[a]*Departamento de Cristalografía y Mineralogía, Facultad de Ciencias Geológicas, Complutense University, 28040 Madrid, Spain*
[b]*Departamento de Ciencias de la Tierra y Química Ambiental, Estación Experimental del Zaidín (CSIC), 18008 Granada, Spain*
[c]*CREGU-G2R, BP 23, 54501 Vandeouvre les Nancy, France*

Received 1 January 2001; received in revised form 15 August 2001; accepted 4 September 2001

Abstract

The Spanish Central System has been subjected to repeated fluid incursions, which were responsible for a variety of mineralizing episodes including W–Sn, Cu–Zn–Pb–As–(Ag), F–Ba and barren quartz veins. These hydrothermal fluids occurred over a 200 Ma time period and the latest hydrothermal event is recorded in barren quartz veins. This study is a multidisciplinary approach leading to the characterization of the hydrothermal fluids preserved in barren quartz veins, which are spatially but not temporally related to Hercynian upper crustal granites. The veins were dated by the $^{39}Ar/^{40}Ar$ method, and the fluids were examined using petrographic, microthermometric, chemical and isotopic methods. Fluid inclusions in barren quartz veins indicate that two fluids were related to this hydrothermal event. The main part of the quartz veins were formed from an early low salinity (<1 wt% NaCl) H_2O–NaCl fluid. This fluid was trapped at around 270 ± 25 °C and 0.1–1 kbar under sublithostatic to hydrostatic conditions. $\delta^{18}O$ (−9 to 2‰) and δD (−70 to −34.5‰) values indicate a meteoric origin for water, with significant water/rock interactions. The latest H_2O–NaCl–$CaCl_2$ fluid is found in two types of fluid inclusions: a primary liquid–vapour type (16–24 wt% NaCl and 1–12 wt% $CaCl_2$) and secondary hypersaline type (7–15 wt% NaCl and 21–27 wt% $CaCl_2$). Significant Li concentrations in this fluid were confirmed. This late Ca-bearing fluid formed quartz crystals in the central part of the veins, and was trapped at 70–140 °C, at a maximum pressure of 0.5 kbar. The low $\delta^{18}O$ (−20 to −6‰) and δD (−137 to −116‰) values suggest a meteoric origin for this fluid, however its high salinity probably requires a source from Triassic evaporite basins located in the NE tip of the Spanish Central System. Anomalously low isotopic values have been previously reported from kaolinites of Lower Cretaceous age. Anomalous climatic conditions during the Cretaceous appear to be the main reason to explain this very negative meteoric water. Strong isotopic depletion in meteoric water has been observed in modern areas with monsoonal climates. The hydrothermal evolution of barren quartz veins in the Spanish Central System is comparable to other hydrothermal Post-Variscan events in central and south-western Europe related to the opening of the North-Atlantic during Cretaceous time.

Keywords: Fluid inclusions; Stable isotopes; Hydrothermal fluids; Post-Variscan; Spanish Central System

1. Introduction

The Spanish Central System has been subjected to repeated fluid incursions, which are responsible for different types of granite-hosted and metamorphic-hosted mineralization: W–Sn, Cu–Zn–Pb–As(Ag) sulphides, F–Ba and barren quartz veins. Thus, the Spanish Central System offers a good opportunity to analyse a variety of hydrothemal fluids, which may be compared to other hydrothermal Post-Variscan events in Europe. These hydrothermal fluids span a time interval of around 200 Ma. Fluids trapped in the barren quartz veins represent the latest hydrothermal event (Caballero et al., 1992; Tornos, Delgado, Casquet, & Galindo, 2000; Vindel, Lopez, Martín Crespo, & García, 2000). Tungsten base-metal transport were related to aqueous-carbonic fluids (García, Vindel, & López García, 1999a,b; Vindel, Lopez, Boiron, Cathelineau, & Prieto, 1995), fluorite–barite ores to aqueous fluids (Galindo, Tornos, Darbyshire, & Casquet, 1994; Tornos, Casquet, Locutura, & Collado, 1991) and later barren quartz veins to $CaCl_2$ brines (Martín Crespo, López García, Banks, Vindel, & García, 1999). This study encompasses for the first time the whole evolution of hydrothermal events. Ca-bearing fluids have not been previously clearly defined in

* Corresponding author. Fax: +34-91-394-48-72.
E-mail addresses: tmartin@geo.ucm.es (T. Martín Crespo), antodel@eez.csic.es (A. Delgado), evindel@geo.ucm.es (E. Vindel Catena), jangel@geo.ucm.es (J.A. López García).
[1] Fax: +34-95-812-96-00.

0264-8172/02/$ - see front matter
PII: S0264-8172(02)00020-X