

# Fluid evolution and hydrothermal processes of the Spanish Central System

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## Abstract

Fluids related to veins and hydrothermal alterations from the Spanish Central System have been studied. Fluid chemistry has been established using microthermometry and Raman spectroscopy. Special attention has been paid to the evolution of  $P$ – $T$  conditions from early  $\text{H}_2\text{O}$ – $\text{NaCl}$ – $\text{CO}_2$ – $\text{CH}_4$  to later  $\text{H}_2\text{O}$ – $\text{NaCl}$ – $\text{CaCl}_2$  fluids. The different types of fluid systems investigated can be distinguished by their fluid pressure, temperature and salinity features. Under initial conditions the fluid pressure may be high, at lithostatic values, and show a nearly isobaric evolution. The later aqueous fluids drop to hydrostatic pressure with a transition to low pressures, in part due to uplift and erosion. © 2000 Elsevier Science B.V. All rights reserved.

*Keywords:* fluid inclusion; hydrothermal fluid;  $P$ – $T$  evolution; Spanish Central System

## 1. Introduction

The Spanish Central System is a northeast trending mountain chain located in the inner zone of the Hercynian Belt in Spain. It is characterised by the presence of high to medium grade autochthonous metamorphic formations, mostly pre-Hercynian orthogneisses and some pre-Ordovician metasediments, and late Hercynian peraluminous granites (Villaseca et al., 1998). These granitoids form the Guadarrama Range and were emplaced between 345 and 285 Ma (Ibarrola et al., 1987). Several episodes of hydrothermal activity related to periods of fracturing and/or reactivation of previous structures took place from 300 to at least 100 Ma (Caballero et al., 1992). Chronologically, the hydrothermal alterations are as follows: (1) 300–290 Ma W(Sn)—polymetallic sulphide lodes and

greisens; (2) 260 Ma skarn deposits; (3) 260–220 Ma episyenites; (4) As(Ag) veins; (5) 151–156 Ma F (Ba) lodes; and (6) 100 Ma barren quartz lodes. The objective of this paper is to document the evolution in the fluid chemistry and the  $P$ – $T$  conditions during the hydrothermal activity in the Spanish Central System.

## 2. Analytical methods

Microthermometric characterisation of the fluids was performed using a Linkam THMSG 600 stage. The stage was calibrated with the melting-point of solid standards at  $T > 25^\circ\text{C}$  and natural and synthetic inclusions at  $T < 0^\circ\text{C}$ . The rate of heating was monitored in order to obtain an accuracy of  $\pm 0.2^\circ\text{C}$  during freezing, and  $\pm 1^\circ\text{C}$  when heating over the 25–400°C range and  $\pm 4^\circ\text{C}$  over the 400–60°C range.

Salinity is expressed as equivalent wt% of NaCl and was calculated from measurements of the ice melting temperature ( $T_m$  ice) using the equations of

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