

# Sources and composition of fluids associated with fluorite deposits of Asturias (N Spain)

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## ABSTRACT

The fluorite deposits of Asturias (northern Iberian Peninsula) are hosted by rocks of Permo-Triassic and Palaeozoic age. Fluid inclusions in ore and gangue minerals show homogenization temperatures from 80 to 170°C and the presence of two types of fluids: an H<sub>2</sub>O–NaCl low-salinity fluid (<8 eq. wt% NaCl) and an H<sub>2</sub>O–NaCl–CaCl<sub>2</sub> fluid (7–13 wt% NaCl and 11–14 wt% CaCl<sub>2</sub>). The low salinity and the Cl/Br and Na/Br ratios (Cl/Br<sub>molar</sub> 100–700 and Na/Br<sub>molar</sub> 20–700) are consistent with an evaporated sea water origin of this fluid. The other end-member of the mixture was highly saline brine with high Cl/Br and Na/Br ratios (Cl/Br<sub>molar</sub> 700–13 000 and Na/Br<sub>molar</sub> 700–11 000) generated after dissolution of Triassic age evaporites. LA-ICP-MS analyses of fluid inclusions in fluorite reveal higher Zn, Pb and Ba contents in the high-salinity fluids (160–500, 90–170, 320–480 p.p.m. respectively) than in the low-salinity fluid (75–230, 25–150 and 100–300 p.p.m. respectively). The metal content of the fluids appears to decrease from E to W, from Berbes to La Collada and to Villabona. The source of F is probably related to leaching of volcanic rocks of Permian age. Brines circulated along faults into the Palaeozoic basement. Evaporated sea water was present in permeable rocks and faults along or above the unconformity between the Permo-Triassic sediments and the Palaeozoic basement. Mineralization formed when the deep brines mixed with the surficial fluids in carbonates, breccias and fractures resulting in the formation of veins and stratabound bodies of fluorite, barite, calcite, dolomite and quartz and minor amounts of sulphides. Fluid movement and mineralization occurred between Late Triassic and Late Jurassic times, probably associated with rifting events related to the opening of the Atlantic Ocean. This model is also consistent with the geodynamic setting of other fluorite-rich districts in Europe.

Key words: crush-leach, fluid inclusions, fluorite, genetic model, LA-ICP-MS

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## INTRODUCTION

Brines are common mineralizing fluids in sedimentary-hosted ore deposits, but the source of their solutes as well as the metal content remains uncertain in many cases. Recent advancements in analytical techniques applied to fluid inclusions such as Laser ablation-inductively coupled plasma mass spectrometry combined with other geochemical data (microthermometry and crush-leach analyses) can help to characterize not only the metal contents of the fluids but also the source of their major and minor components.

The fluorspar district of Asturias (northern Iberian Peninsula) has been one of the major fluorite producers in Europe with approximately 40 known occurrences (García Iglesias & Loredó 1994) producing more than 15 Mt of ore since the 1970s. This economically important mineralization is found in three districts, Berbes, La Collada and Villabona, where three mines are currently in operation: Emilio in Berbes, La Viesca in La Collada and Moscona in Villabona (Fig. 1). Mineralization occurs as vein and stratabound bodies in highly silicified red-bed sediments (marls and sandstones), carbonates and calcareous breccias of Permo-Triassic age (García Iglesias & Loredó 1994), and