First Evidence of a Gold-Bearing Skarn Deposit in the Catalan Coastal Ranges

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Palabras Clave: Skarn, Oro, Cordilleras Costeras Catalanas. **Key Words:** Skarn, Gold, Catalan Coastal Ranges.

INTRODUCTION

The Catalan Coastal Ranges (CCR), NE Spain, host a wide variety of ore deposits related to Paleozoic basement metamorphic and igneous rocks. Mineral occurrences in the Montseny-Guilleries massif include magmatic-hydrothermal ores such as the Gualba skarn deposit and hydrothermal vein deposits such as Les Mines d'Osor (e.g., Ayora et al., 1990). Within the Guilleries Massif, the Camí del Clascar ancient mine represents a Fe-(Cu-Zn) occurrence that was historically exploited in the 20th century. Although recent studies at this deposit revealed the occurrence of Au (Meroño, 2024), a detailed mineralogical investigation is needed to understand its mineral paragenesis and deposit model. This study aims to recharacterize the Camí del Clascar ore through fieldwork, petrographic and mineralogical analyses to define its mineralization style and evolution.

GEOLOGICAL CONTEXT

The Les Guilleries Massif, located in the NE of the CCR, is mainly composed of Cambro-Ordovician metasedimentary units and orthogneisses cut by Variscan intrusions. The massif is divided into three blocks separated by NE-SW normal faults (Martínez et al., 2011). The Camí del Clascar deposit is hosted in the Osor block, which represents the deepest crustal level of the massif. It is characterized by sillimanite-grade metamophic rocks such as metapelites, metapsammites, calc-silicate rocks, amphibolites and orthogneisses (Martínez et al., 2008). Several Variscan igneous bodies intruded extensively into the metamorphic rocks. The intrusive complexes include ~323 Ma quartz-diorites, diorites, and hornblende gabbros; 305-299 Ma granites; ~284 Ma porphyritic granitoids, and 262-265 Ma lamprophyres (Martínez et al., 2008; Mellado et al., 2022). The hydrothermal activity is thought to have generated epigenetic mineralizations such as Camí del Clascar (Meroño, 2024).

MATERIALS AND METHODS

This study uses 81 samples from mineralized zones and host rocks of Camí del Clascar collected from previous works and stored at UAB. Petrographic and mineralogical analyses of 20 selected representative samples were carried out using transmitted and reflected light microscopy, complemented by scanning electron microscopy coupled with energy-dispersive spectroscopy (SEM-EDS; Zeiss EVO MA) at an operating voltage of 20 kV to corroborate and/or identify minor mineral phases. Eight samples were dried, ground to <75 µm, and mounted in back-loading holders, and analyses were performed using a X'Pert-Philips diffractometer with Cu radiation and a PIXcel1D detector under operating conditions of 40 kV and 40 mA, a scan rate of 5°/min over a 4-60° (2θ) range. The mineral phases are identified using the PANalytical X'Pert HighScore v.20 software and the PDF-2 database.

MINERALOGY AND PETROGRAPHY

Field observations reveal a subvertical quartz-feldspar-biotite granite porphyry dike (1-1.5 m thick) intruding calcic marbles interlayered within metapelites. The dyke displays chilled margins and mildly sericitized plagioclase and chloritized biotite. Calc-silicate mineral assemblage defines a well-developed proximal-to-distal zoning. The proximal zone is dominated by garnet>>pyroxene (Fig. 1A). Garnet is composed of centimetric andradite (locally andradite-grossular) crystals with compositional zoning from Al-rich cores to Fe-rich rims and displaying granoblastic texture. Garnet intergranular spaces are filled by pyroxene, magnetite, pyrrhotite, chalcopyrite and sphalerite. The distal zone is dominated by pyroxene>wollastonite>>garnet (Fig. 1B). Pyroxene (hedenbergite>diopside>>johannsenite) extends over several meters from the intrusion. Amphiboles and epidote occur together locally replacing pyroxenes. The sulfide assemblage in the distal zone is characterized by sphalerite, with minor chalcopyrite and pyrrhotite inclusions, and traces of galena and magnetite.

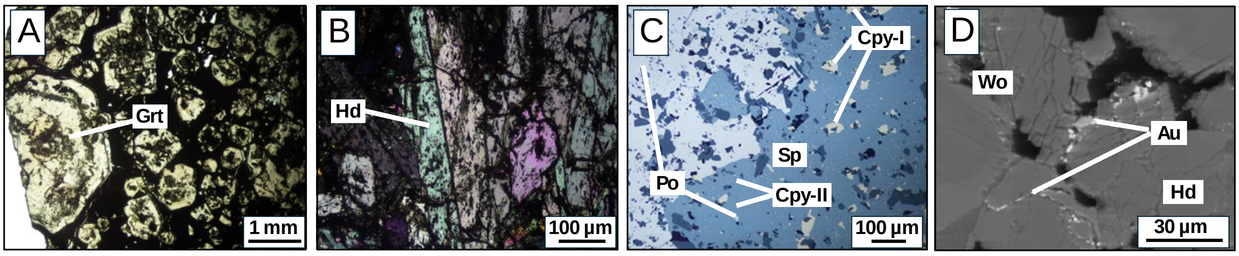

Fig 1. *Mineralogy of the Camí del Clascar deposit (Meroño, 2024). A) Transmitted light photomicrographs (TLP) of garnet (Grt) alteration zone. (B) TLP of pyroxene (Hd: hedenbergite) alteration zone. (C) Reflected light photomicrograph of ore zone (Po: pyrrhotite; Cpy: chalcopyrite; Sp: sphalerite). (D) SEM-backscattered electron image showing native gold (Au) in fractures and interstices within hedenbergite and wollastonite (Wo).*

The main ore zone consists of a massive sulfide body up to 12 m long and ~1 m thick with a structural orientation of 257/17. It is dominated by pyrrhotite with abundant chalcopyrite and minor sphalerite (Fig. 1C), recording a progressive evolution from Fe-rich to Cu-Zn sulfide assemblages. Chalcopyrite replaces pyrrhotite and is closely associated with minor augite, ferro-actinolite (100–150 µm), tremolite, epidote, fibrous chlorite and titanite. Magnetite (~100 µm) is commonly intergrown with chalcopyrite, whereas sphalerite replaces pyrrhotite and exhibits well-developed chalcopyrite disease textures (Cpy-II), with abundant pyrrhotite and galena inclusions (<50 µm). Pyrrhotite, which is locally fractured, locally replaced by marcasite, forming characteristic "bird's eye" intergrowths, and hematite. Native bismuth, bismuthinite, acanthite, native silver, and hessite occur in fractures and interstices. Moreover, Au particles are found in the pyroxene>garnet zone, mainly as Pd-alloys and native gold of <10 µm in size (Fig. 1D), both within pyroxene and wollastonite fractures and cleavage.

DISCUSSION AND CONCLUSIONS

The Camí del Clascar deposit is interpreted as a calcic exoskarn system formed through hydrothermal fluid interaction associated with a granite porphyry dike, as pointed by Meroño (2024). The mineralogical zoning reflects a classical metasomatic gradient from garnet to pyroxene to sulfide-dominated assemblages, with no evidence of endoskarn development. The prograde stage involved replacement of marble by wollastonite followed by hedenbergite and andradite with early magnetite and pyrrhotite precipitation. The retrograde stage is composed of actinolite, amphiboles, epidote, and pyrrhotite-chalcopyrite-sphalerite-galena. Later hydrothermal activity introduced Bi, Ag, Au, Pd and Te into the skarn system. The dominance of Fe-sulfides and low abundance of magnetite support an interpretation as a Fe-Cu±Zn-Pb skarn with relevant Au-Ag-Pd-Te enrichment. This represents the first documented gold-bearing skarn mineralization in the Catalan Coastal Ranges and suggests a complex metallogenic evolution, with potential economic significance (Theodore et al., 1991).

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