The Puagjanca Zn-Pb(-Ag) pipe in the Miocene Santander-Chungar district, Central Peru.

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1. Abstract

The Puagjanca pipe in the Miocene Santander-Chungar district, Central Peru, is a classic example of Zn-Pb-(Ag) mineralization associated with skarn. The ore consists of Fe-rich sphalerite, and galena overprinting calc-silicates. The deposit is largely a distal skarn developed in Cretaceous carbonate rocks. Available dating elsewhere in the district suggests that Puagjanca has a late Miocene age.

2. Introduction

Significant mining in the Chungar area (Fig. 1) dates back mainly to the second half of the twentieth century and up to 1971 when a massive landslide into the Yanawayin Lake stopped production of the mine exploiting the Chungar Zn-Pb-Cu-Ag skarn deposit (11°07′27″S 76°31′56″W, Soler and Bonhomme, 1988). In 2015, Volcan Compañía Minera acquired the property and explored several targets identified by a previous owner. Of these, the Puagjanca pipe (11°09'44"S 76°31'02"W) was defined at 14.5 Mt with 4.63% Zn, 2.72% Pb, 42.1 g/t Ag (measured, indicated, and inferred resources at Zn equivalent cut-off of 2 %, December 2019). The similarities of the Zn-Pb-Ag skarn-related deposits and ore showings in the Santander (Kingsley et al., 2019) and Chungar areas were already noted by Petersen (1965) and Noble and McKee (1999) and allow to use, as part of the Miocene polymetallic belt of Central Peru (Noble and McKee, 1999), the term Santander-Chungar District that from south to north includes the Zn-Pb-(Ag-Cu) deposits of Santander, Magistral (only active mine presently), Puagjanca, and Chungar, as well as Don Miguel and other ore showings (Fig. 1). Main host rock are Cretaceous carbonate rocks. NNW-SSE-trending strike-slip faults, and parallel West-plunging overthrust faults and tight anticlines and synclines, as well as NE trending steep faults are the major structures in the District. Late Miocene (~13 to 10 Ma, Soler and Bonhomme, 1988; Bissig et al., 2008, see details below) granitic and granodioritic intrusions post-date the main deformation. In the district occur also minor andesitic sills and dykes. One of them, trending NNW-SSE, located 250 m East of the Chungar granite, was dated by Soler and Bonhomme (1988) at 25.1±1.6 Ma (K-Ar, whole rock).

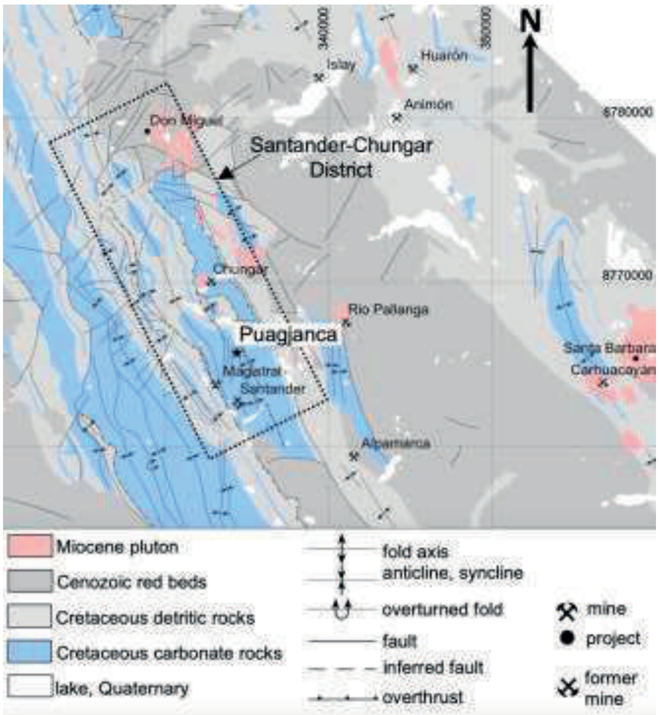

Fig. 1 Simplified geological map of the Santander-Chungar District and nearby areas.

3. The Pugjanca pipe

The Puagjanca pipe is emplaced sub-vertically down 650 m from a surface outcrop at 4950 in the axis of a NNW trending anticline formed by Cretaceous carbonate, marls, and siliciclastic sedimentary rocks whereby the skarn replaces mainly clean limestones (Fig. 2). The pipe is zoned with Fe-rich sphalerite – galena ratios decreasing from a deep portion with Zn:Pb ratios >10 to the middle and upper portions, that make up the main part of the ore, where the Zn-Pb ratios are around 3 to 1 (Fig. 2). Silver contents in the ore body are fairly proportional to the abundance of galena. Mineralization is open at depth where it occurs as Fe-rich sphalerite veins predominantly devoid of galena.

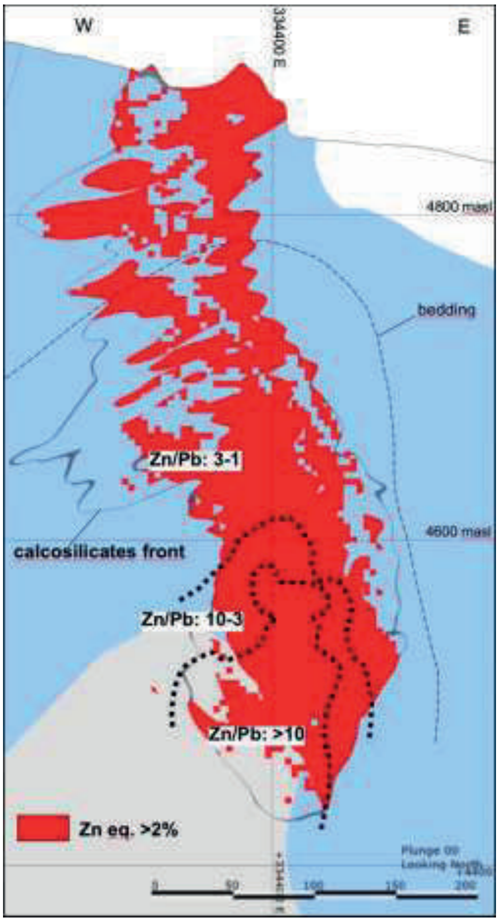

Fig. 2 Schematic W-E cross section of the Puagjanca pipe.

Similarly to the Santander deposit with which it shares its pipe morphology and position in the axis of an anticline, no major intrusive rocks directly connected to the skarn mineralization have been observed so far except for a monzonite dyke less than two meter thick. However, in the near inactive Zn-Pb-(Cu-Ag) Chungar mine (Fig. 1), Soler and Bonhomme (1988) described a granite in contact with skarn mineralization with similar mineral assemblages as in Puagjanca. This granite was dated by Bissig et al. (2008) at 12.88 ± 0.36 Ma (Ar/Ar biotite plateau age), age consistent with less precise previous biotite K-Ar ages around 13.3-13.5 Ma by Soler and Bonhomme (1988). These authors dated also the Chalhuacocha granodiorite at 10.0± 0.3 Ma (K-Ar on biotite), located 1 km of the Don Miguel Zn-Pb-Ag prospect (11°03'00"S, 76°33'25" W) 8 km north of the Chungar Mine). These ages and those between 11.42±0.06 and 10.88±0.0 Ma (Re-Os in molybdenite) in quartz-molybdenite veins in the Santander Mine property obtained by Kingsley et al. (2019) suggest that the Puagjanca pipe has a similar late Miocene age.

A low-sulfidation assemblage consisting mainly of Fe-rich sphalerite, pyrrhotite, galena, minor amounts of chalcopyrite, as well as chlorite and minor amphibole and serpentine overprints garnet and other calc-silicates and makes up the majority of the ore (Figs. 3 to 6). In places, coarse-grained, partly idiomorphic pyrite comparable to that of “stage B” in many Cordilleran polymetallic deposits (Rottier et al., 2016, 2018; Fontboté, 2020) overprints the low-sulfidation mineral assemblages (Fig. 6). Replacement of pyrrhotite by marcasite (“intermediate product” of Ramdohr, 1982) is also frequent in this Stage B. Intermediate-sulfidation assemblages comparable to Stage C with Fe-moderate sphalerite, Ag-bearing sulfosalts, Fe-Mn carbonates, and sericite occur in thin veins. Minor supergene alteration with development of smithsonite and Zn bearing clays is observed along certain faults in the upper part of the pipe.

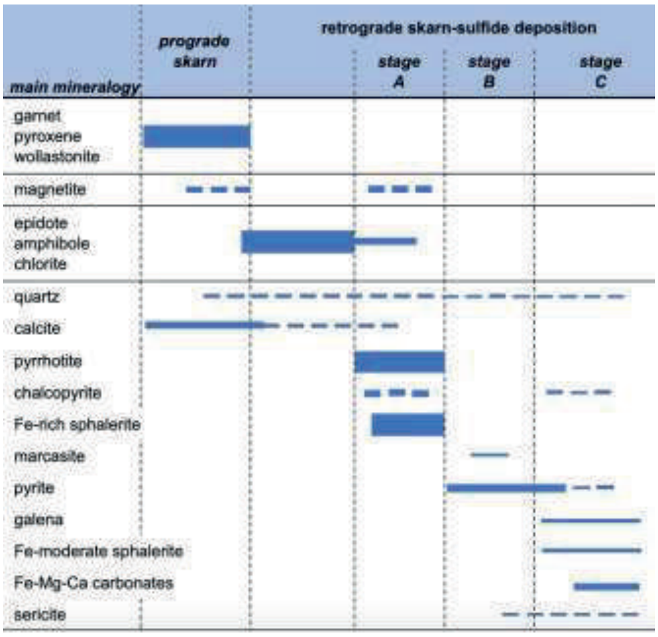

Fig. 3 Simplified paragenetic sequence of the Puagjanca pipe. Stage terminology according to Fontboté (2020).

4. Discussion and conclusion

The mineral sequence of the retrograde assemblages of Puagjanca is reminiscent of the three-stage evolution of numerous Cordilleran polymetallic deposits (Fontboté, 2020), whereby here, as typical for Zn-Pb-Ag distal skarns, he first low-sulfidation stage dominates. Recognition during logging and field work of "stage B" partly idiomorphic coarse-grained pyrite overprinting the previous low-sulfidation assemblages is key to trace the evolution of the system and to explore transitions to Cordilleran deposits, as observed, for example, in the nearby Carhuacayán polymetallic deposit (Bernaola et al., 2019)

Fig. 4 Massive ore consisting mainly of Fe-rich sphalerite typical for the richest portions of the Puagjanca pipe. Drill core width: 6.3 cm

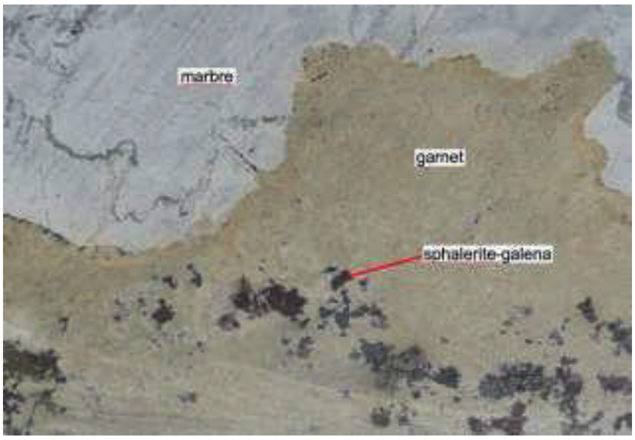

Fig. 5 Contact of garnet skarn with clean Cretaceous limestone affected by contact metamorphism. Image width: 6 cm.

The size and grade of the Puagjanca ore body and its similarity with other structurally-controlled polymetallic deposits in the Santander-Chungar district, underlines the potential of the area for porphyry related polymetallic skarn and Cordilleran mineralization.

Acknowledgement

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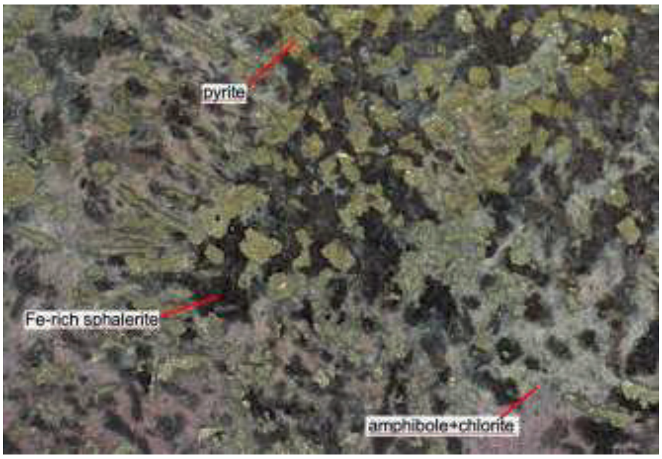

Fig. 6 Stage B coarse-grained pyrite overprinting the Stage A low-sulfidation assemblage with Fe-rich sphalerite, amphibole and chlorite that makes up most of the Pugjanca ore. Image width: 4 cm.

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