

A mineralogical study of the Pablo y Virginia mine (Mining Park of La Unión, Murcia / Spain): preparing the site for its future adaptation as a “museum mine”

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INTRODUCTION

The Sierra de Cartagena (eastern Betic cordilleras) is a polymetallic (Pb, Ag, Zn, Fe, Mn, Cu, Sn,) mining district, with an ancient mining history dating at least from the third century BC and extending well into the 20th Century (1991). The sierra has a great geological and mining heritage value (Manteca et al, 2005, López Garcia et al, 2011) that was eventually recognized in 2009, when the area was declared Site of Cultural Interest in the category of historical site. A series of initiatives have been undertaken in the last years by the regional and local governments, and the Technical University of Cartagena, to showcase the Sierra de Cartagena mining heritage. These efforts culminated in July 2010 with the official nomination of the area as “Mining Park of La Union”. This decisive action also involved the adaptation of an old mine (Agrupa Vicenta) as a museum mine (and therefore as a tourist attraction), that is currently receiving about 40,000 visitors per year (Luengo et al, 2008). The City Council of La Union is at present trying to increase the tourist offer and conducting the adaptation of another mine (Pablo y Virginia) for the same purposes in the park.

Transforming a mine into a “museum mine” goes beyond the mere tourist attraction concept, involving a major effort towards scientific divulgation. This is the reason why we undertook the mineralogical study of an otherwise poorly known ore deposit: that is, to offer to the potential visitors an enhanced scientific vision of the site

GEOLOGICAL SETTING

The Sierra de Cartagena is a coastal

WSW-ENE trending mountain block belonging to the much larger Betic Cordilleras, the westernmost European Alpine chain. Two main tectonic Alpine units characterized by the superposition of several thrust sheets are recognized in the area: 1) the meso-metamorphic Nevado-Filábride Complex (Paleozoic-Triassic); and 2) the epi-metamorphic Alpujárride Complex (Permian-Triassic). These units are in turn covered by Miocene marine sedimentary series, and cross-cut by: 1) high-K calc-alkaline subvolcanic and volcanic rocks of late Miocene age (dacites and andesites); and 2) Plio-Quaternary alkali basalts (Manteca y Ovejero, 1992).

The late Miocene magmatism triggered hydrothermal activity resulting in formation of polymetallic mineral deposits: manto-type, veins, disseminations and stockworks (Oen et al, 1975; Manteca and Ovejero, 1992). From an economic perspective the mantos are by large the most important type in the district.

On the other hand, the formation of the sierra can be regarded as the consequence of the late Miocene horst and graben extensional tectonics (and coeval volcanism) that ultimately resulted in the uplifting of the Sierra de Cartagena tectonic block. Oblique normal faulting resulted in formation of the so-called Las Lajas horst, which is part of a major NW-SE structural corridor that divides transversely the Sierra de Cartagena (Manteca and Ovejero, 1992). Combined and sequential uplifting along the ENE (Sierra de Cartagena) and NW (Las Lajas) trends explains why the underlying complex (Nevado Filábride) crops out along most of the Las Lajas horst (Manteca and Ovejero, 1992). These fractures also guided the emplacement of andesitic-rhyodacitic

magmas, resulting in the emplacement of domes, dikes, subvolcanic necks, and subsequent hydrothermal activity and ore mineral deposition (Fe, Pb, Zn, Cu, Ag, Sn, etc.) (Manteca et al, 2008).

THE PABLO Y VIRGINIA MINE

The Pablo y Virginia mine started operations in 1869 by the traditional method of “room and pillar”. Although the claim was initially listed as a “lead” mine, the fact is the dominant and almost exclusive mined mineral was pyrite (plus small amounts of “copper pyrites”). Mining continued intermittently until the end of the 1960s, and the production was intended for the chemical plant “Productos Químicos de Cartagena” to manufacture sulphuric acid.

The existence of tin minerals in the Sierra de Cartagena was not unheard of and as in fact tin mining had already began in 1870, reaching its peak at the beginning of the 20th Century. However, this extraction always remained as a marginal activity because of the small thickness of the veins and the difficulty to concentrate the tin oxide. Tin production finally ended in 1957. Furthermore, in the vicinity of the Pablo y Virginia mine (Cuesta de Las Lajas), tin was also mined from the Remunerada mining site. There the ore consisted of the xylloid (wooden-type) cassiterite, and occurred in thin veins hosted by the Nevado Filábride Paleozoic schists (Arribas et al, 1984).

Pablo y Virginia mineralization

The ore body at Pablo y Virginia consisted of a 4 to 8 m thick low-angle pyrite-rich manto type deposit (the so-

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called "manto piritoso") that formed by metasomatic replacement of Triassic marbles belonging to the Nevado-Filábride Complex (Manteca and Ovejero 1992). In some sectors the replacement was not complete, remaining some residual marble enclaves into the mantle. The manto has a banded structure, with a few cm thick bands of pyrite, chlorite and quartz. This banding mimics a relic schistosity ("ghost schistosity") found in the original (unaltered) marbles. Additionally, small veins crosscutting the stratiform ore are thought to correspond to a later stage of mineral remobilization.

The ore body crops out at the surface as an ochre coloured (gossan) oxidized level, visible in several sectors along the old Ruta del 33, a restored old local road that linked La Unión and Portman along the Cuesta de Las Lajas.

Mineralogical description

The manto mineralization consists of intergrowths of pyrite, minor cassiterite, quartz (I), chlorite and carbonates. In this regard, two mineralization stages can be defined. This first stage consisted of disseminations of pyrite in a matrix of quartz and minor chlorite. It was precisely within this mineralization stage that cassiterite was formed, and can be observed as small grains spatially associated with pyrite. We would like to highlight the fact that this is the first observation of cassiterite in the Pablo and Virginia ore deposit. Thin "crowns" of carbonate (s.l.) surround the larger quartz grains.

The second stage involved deposition of coarse idiomorphic quartz (II) and an increase in chlorite and carbonates. The latter have a composition close to siderite with variable amounts of Mn y Ca, although we observed a chemical pattern defined by a decrease in these elements from core to rim. Accessory minerals include fluorapatite, rutile and galena. Sphalerite is very scarce.

On the other hand, the small vein mineralization consists of quartz with comb texture accompanied by sulphides: pyrite, chalcopryrite and galena. In the final stage of crystallization, xyloid cassiterite infilled the voids and cross cut all the previous textural features. This cassiterite is similar to that observed at the neighbouring Remunerada mine. Supergene alteration of the primary

sulphides, lead to formation of covellite, hematite, goethite, and Cu and Pb secondary minerals such as cerussite and anglesite. Current formation of metastable Fe sulphates phases such as melanterite and rozenite is observed within the mine.

DISCUSSION AND CONCLUSIONS

This study shows for the first time the existence of primary cassiterite at the Pablo y Virginia Mine. This is not entirely surprising for a metallogenic cluster where other deposits also have the Sn signature in their mineral parageneses (e.g., La Crisoleja, Remunerada) (Arribas et al, 1984). In addition, Kager (1980) indicates the presence of other Sn-bearing mineral: stannite as inclusions within sphalerite in the Sierra de Cartagena block, particularly in the Cabezo Rajao mine, but does not mention cassiterite. Besides, Oen et al, 1980 also indicate the existence of estannite rich zoned sphalerite at the Julio César mine.

Crystallization temperatures estimated using the geothermometer of Cathelineau (1988) for chlorites ranging between 210°C and 310°C. These temperatures, would be consistent with the proposed by Oen et al (1975), around 250°C, and minor that proposed by Kager (1980) for the second stage of mineralization (around 330°C), based on the proportion of accessory elements (Cd and Mn) in sphalerite.

Finally, what started as a conventional mineralogical study with the purpose of filling a void in our knowledge on a mine that was about to become a site of interest for visitors, has opened new perspectives for the understanding of the Sierra de Cartagena Pb-Zn-(Sn) ore deposits cluster. In this regard, a museum mine should not be too different from what a science museum is: a site that goes beyond the typical tourist attraction and becomes a place where scientific research can and must be done.

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