La Bodega and La Mascota Deposits, California Vetas Mining District, Colombia: Geology, Alteration, Mineralization.

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Introduction

La Bodega (LB) and La Mascota (LM) deposits (inferred resources of 3.47 Moz Au, 10.2 Moz Ag, and 64.4 Mt Cu at 2 g/t Au cut off; Albrecht et al., 2019) are located in the California-Vetas Mining District (CVMD), 35 km NE of Buritama, in the Eastern Cordillera of Colombia (Fig. 1). The deposits have characteristics of epithermal and porphyry-style deposits but are hosted in the Precambrian intrusives of the Santander Massif. The principal test to mineralization in the Buritama Greenstone of Proterozoic age is cut by Jurassic- Cretaceous biotite granite stocks and intermediate bodies (Fig. 2). The mineralization exhibits prominent NE trending, NW-dipping structural control. LM mineralization is mainly composed of porphyry-style veins (Fig. 3) and minor identified breccias (Fig. 3) while LM mineralization is largely contained in multi-phase hydrothermal breccias (Fig. 4) with minor vein zones adjacent to the breccias. The area has undergone intense exploration in recent years, recoveries of gold and nature of the hydrothermal fluids have not been yet defined. This project aims to comprehensively describe the geology, alteration and mineralization of LB and LM, define the paragenetic sequence for the mineralization events and make a comparison between the two deposits, and define origin and nature of the mineralizing fluids.

Alteration and Mineralization

Hydrothermal alteration assemblages at LB and LM deposits are typical of those found associated with porphyry and epithermal systems and are directly related to mineralization events. The main alteration types and veins related are: 1) propylitic (Fig. 5), chlorite and oxide alteration, hosted in foliated andesite and andesitic tuff breccias. This alteration is accompanied by quartz veins, calcite, sericite, and minor hematite; 2) phyllic (Fig. 6), muscovite (chlorite)+ illite, phengite, biotite (chlorite)+ illite and quartz veins; 3) sericite+ quartz veins (Fig. 7), accompanied by minor hematite, chlorite, pyrite, and magnetite. These vein assemblages are present in altered rocks and not in unaltered rocks. The presence of these vein assemblages is related to the extension of the alteration zone and the presence of faults and fractures that allow the introduction of hydrothermal fluids. The alteration assemblages at LB and LM deposits are related to the extension of the alteration zone and the presence of faults and fractures that allow the introduction of hydrothermal fluids.

Stable Isotope Geology

Pyrite sulfur isotopes

Sulfur isotope ratios ranging from -8.5% to -11.4% at La Mascota, -9.2% to -12.1% at LB deposits, and -10.1% to -11.5% at Le Borda deposits have been found (Fig. 8). These isotope ratios are consistent with the formation of pyrite from magmatic fluids and the introduction of pyrite into the mineralization by hydrothermal fluids. The sulfur isotope ratios at LB and LM deposits are consistent with the formation of pyrite from magmatic fluids and the introduction of pyrite into the mineralization by hydrothermal fluids.

Origins of the mineralizing fluids

Sulfur derived from magmatic fluids is characteristic of most of the mineralizing fluids. The sulfur isotopic ratios range from -8.5% to -11.4% at La Mascota, -9.2% to -12.1% at LB deposits, and -10.1% to -11.5% at Le Borda deposits. These sulfur isotopic ratios are consistent with the formation of pyrite from magmatic fluids and the introduction of pyrite into the mineralization by hydrothermal fluids. The sulfur isotopic ratios at LB and LM deposits are consistent with the formation of pyrite from magmatic fluids and the introduction of pyrite into the mineralization by hydrothermal fluids.

Conclusion

Based on the characteristics observed, LB is considered the shallower part of a porphyry system overprinted by gold-rich, argillic alteration and high sulfidation epithermal mineralization. LB and LM deposits are typical of those found associated with porphyry and epithermal systems and are directly related to mineralization events. The presence of these vein assemblages is related to the extension of the alteration zone and the presence of faults and fractures that allow the introduction of hydrothermal fluids.