Metallogenesis of the Quebrada del Diablo Lower deposit, Gualcamayo Mining District, Argentina

D’Annunzio, María Celeste*; Cuadra, Ignacio2; Rubinstein, Nora3

3. IGEBA CONICET-UBA. Pabellón 2, Ciudad Universitaria, CABA, Argentina

* E-mail: celeste.dannunzio@uns.edu.ar

Summary The Gualcamayo mining district (68°38’26”O; 29°43’10”S) is located in the Precordillera of San Juan province, Argentina. It is hosted by carbonate rocks of the Cambro-Ordovician age which were intruded by Miocene magmatic rocks. The district includes a disseminated gold deposit in calcareous breccias (Quebrada del Diablo Main), a polymetallic skarn with Au mineralization (Amelia Ines-Magdalena) and a disseminated gold deposit in breccias called (Quebrada del Diablo Lower West). Quebrada del Diablo Lower West is a blind body that lies between 500 and 600m deep that it is the result of two mineralizing stages. The first one, hosted mainly in tectonic breccias, consists of pyrite, marcasite, sphalerite and gold in calcite and quartz gangue. The second one cuts the first and conforms breccias or veinlets of realgar, orpiment and Au/Hg tellurides in calcite gangue. Fluid inclusion studies reveal that this second stage was produced by fluids of low to moderate temperatures and very low salinities.

Key words: Disseminated Au, ore paragenesis, epithermal, Precordillera of San Juan.

1 Introduction

The Gualcamayo mining district (68°38’26”O; 29°43’10”S) is located in the Central Precordillera of San Juan province, Argentina (Figure 1). The Central Precordillera is a fold and thrust belt of thin skin that is limited eastwards by thick skin structures of the Eastern Precordillera (Giampaoli and Cegarra 2003; Figure 1).

The district includes the following deposits: Quebrada del Diablo Main which is a disseminated gold deposit in calcareous breccias and is currently being mined (Bruno 2004, 2005); Amelia Ines-Magdalena which corresponds to a skarn deposit of Fe, Cu, Pb, Zn (Logan 1999) with Au mineralization and Quebrada del Diablo Lower West which is an ore body with disseminated gold mineralization, emplaced in breccias (D’Annunzio, Rubinstein, and Dimieri 2014; D’Annunzio and Rubinstein 2013b; Soechting et al. 2009).

2 Geological setting

The Precordillera is an Andean N-S fold and thrust belt which extends over 400 km that average around 80km in with. It lies over a Paleozoic sedimentary sequence as a result of eastward migration of the orogenic front.

In the area of Gualcamayo mining district there are Paleozoic sequence consists of thick calcareous beds of Cambrian to Ordovician age (Los Sapitos and San Juan Formations) which are overlaid by Ordovician marine deposits (Gr. Trapiche) and Carboniferous to Permian continental deposits (Volcán, Panacán and Ojo de Agua Formations, Furque 1963).

The Paleozoic sequence is intruded by dacitic porphyries and dikes corresponding to the Gualcamayo Igneous Complex (Bruno 2005; D’Annunzio and Rubinstein 2014b; Simon et al. 2001). This complex resulted from an upper Miocene (9-5 Ma) magmatic arc emplaced in a crust of normal intermediate thickness (~45km). Associated to this magmatism, an important hydrothermal activity caused potassic and minor propylitic alteration (D’Annunzio and Rubinstein 2013a, 2014a).

The regional structure consists of a imbricated fan of y fault propagation folds and out of sequences thrusts related to the lifting of the Eastern Precordillera structures (Giampaoli and Cegarra 2003).

In the study area, the major structures are NNW-SSE thrusts with marked deflections along the strike. The fault surfaces dip WSW and are generally parallel or subparallel to the dips of the layers (25° and occasionally 65°), forming predominantly low-angle and exceptionally high-angle thrusts. La Silla-Alaya thrust places the Cambro-Ordovician carbonate rocks on the Upper Miocene sedimentary rocks that correspond to the El Corral Formation. In the Portezuelo Tamberías area, the overthrust is cut by a major WNW-ESE sinistral sliding fault of. The Tamberías structure acts as a transfer fault for the compressive SW-NE strain. The morphology of the Tamberías fault determine gneration of compressive and extensive strain and the location of the minor scale structures (sigmoid, in echelon, riedel etc), that host the mineralization (Soechting et al. 2009).
3 Quebrada del Diablo Lower West Deposit

3.1 Structural control

Quebrada del Diablo Lower West is a blind ore body that lies between 500 and 600 m deep. It is an E-W elongated body of 500m long, 100 m wide and 80m thick (Soechting et al. 2009).

The mineralization is hosted by breccias with a significant variation in the amounts of clasts, matrix and cement, as well as in the composition and size of the clasts. Based on their textural characteristics they were classified as tectonic breccias with fluid assistance (with scarce or lack of clastic matrix and abundant cement, see D’Annunzio et al. 2014) or without assistance of fluids (with abundant clastic matrix, attrition evidence and growth of clays, see D’Annunzio et al. 2014).

3.2 Mineral paragenesis

Mineralogical studies reveal that the Quebrada del Diablo Lower West ore body is the product of two mineralizing stages.

The first stage (Figure 2) resulted in a black to gray massive aggregate, consisting mainly of pyrite and marcasite with minor sphalerite and scarce gold. Pyrite occurs in subhedral to euhedral crystals of 50 to 100 µm in size. It has abundant inclusions of Pb sulfosalt, galena and/or scheelite (Figure 2 a3 and a4). Marcasite occurs in anhedral crystals between 20 and 50µm conforming aggregates which replace the pyrite (Figure 2 a1). Sphalerite occurs as anhedral crystals up to 50µm. Sphalerite and pyrite intergrowths are common (Figure 2 a2). The gangue consist of coarse-grained esparitic carbonate, fine-grained carbonate and minor microcrystalline quartz aggregates (D’Annunzio et al. 2014; D’Annunzio and Rubinstein 2013b; D’Annunzio 2012).

The second mineralizing stage (Figure 2 b), led to a realgar, orpiment, and Au paragenesis with a calcite gangue in veinlets up to 30cm thick or as breccia cement. The realgar occurs as crystal aggregates and the orpiment (Figure 2 b1 and b2) as radial aggregates consisting of small acicular crystals forming. SEM-EDS analyses reveal that the gold occurs as short tabular crystals of calaverite (AuTe₂; Figure 2 b3 y b4). Coloradoite (HgTe) is also present and sometimes is inter- grown with the Au telluride (Figure 2 b 3).

3.3 Fluid inclusion studies

Microthermometric studies carried out in primary, pseudosecondary and secondary fluid inclusions (IF) of calcite crystals in veinlets that correspond to the second mineralizing stage, returned the values shown in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Th (°C)</th>
<th>Tf (°C)</th>
<th>Average salinity (% of equivalent NaCl)</th>
<th>Average density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>24</td>
<td>335 a 203,4</td>
<td>-1,3 a - 0,5</td>
<td>1,504</td>
<td>0,830</td>
</tr>
<tr>
<td>Pseudo-secondary</td>
<td>23</td>
<td>185 a 152</td>
<td>-1 a - 0,5</td>
<td>1,303</td>
<td>0,879</td>
</tr>
<tr>
<td>Secondary</td>
<td>52</td>
<td>148 a 85</td>
<td>-1 a - 0,2</td>
<td>1,045</td>
<td>0,947</td>
</tr>
</tbody>
</table>

Figure 3: Homogenization temperature vs. salinity diagram (Camprubi 2010). Arrows indicate the tendency of fluids according to the acting process.

The results show a general range between 335 and 85°C with salinities up to 1.5% (Table 1). The higher temperatures and salinities correspond to primary and pseudo-secondary IF (Figure 3), while in secondary IF the values are lower suggesting that they are the result of colder and diluted fluids.

4 Discussion and Conclusions

Mineralogical studies carried out in Quebrada del Diablo Lower West reveal that the Au mineralization is the product of two mineralizing stages. The first stage resulted in a paragenesis of pyrite-marcasite – sphalerite – gold in a calcite and quartz gangue that cements tectonic breccias. The second one resulted in a realgar, orpiment-calaverite-coloradoite paragenesis in a calcite gangue that occurs in breccias and veinlets.
The IF studies results shows that the mineralization fluids of the second stage has temperatures an salinities typical of the epithermal systems, that underwent a dilution process.

Acknowledgements

The authors thank to MASA Company (Minas Argentinas SA) for the logistic support in the field work and the geologists and technical staff of the exploration area for their cooperation. This research was partially funded by the PIP 11220090100589 project (CONICET).

References


Figure 1: a) Location Map of Gualcamayo mining district in the Andean foothills area of Argentina. b) Satellite image of the district where the main structural features are highlighted. c) Simplified geological map of the district with the location of mineral deposits mentioned in the text (Modified from D’Annunzio et al. 2014)

Figure 2: a) Mineralized breccias, where the first pulse dominates. a1) Photomicrographs of pyrite (Py) altered to marcasite (Ms) in carbonate gangue (Ca). a2) Image showing backscattered electrons of sphalerite (Sph) and pyrite (py) intergrowths. a3) & a4) Image showing backscattered electrons of galena inclusions (Gn) and Pb sulphosalt (Sf) in pyrite (Py), respectively. b) Breccia mineralized mainly with the second pulse. b1 and b2) Pyrite crystals (Py) belonging to the first mineralizing pulse, deformed, brecciated and filled with orpiment crystals (Orp) and carbonatic gangue (Ca). b3) Image showing backscattered electrons of an irregular crystal form of calaverite (Cal) and coloradoite (Co). b4) Euohedral crystal in short tablet form of calaverite (Cal).