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"THE GEOLOGY AND GEO-METALLURGY OF CORANI; A SIGNIFICANT NEW EPITHERMAL SILVER/ BASE-METAL/ GOLD DEPOSIT; PUNO PROVINCE, PERU"

Christian Rios

Calle Teruel 186, Miraflores, Lima, Perú

INTRODUCTION

The Corani deposit is located 200 kilometers north of the provincial capital of Puno in the Cordillera Oriental arc of the Central Andes within the Atlantic drainage (Fig. 1a, 1b). Elevations range from 4,675 to 5,260 meters above sea level within a north-south trending U-shaped valley formed by glaciation. Temperatures range from -10ºC to 10ºC with light rain and snowfall commonly from December through March. The climate is characteristic of the high, arid deserts of the adjoining Bolivian altiplano and vegetation is sparse. Corani is a large, structurally controlled, low to intermediate sulfidation epithermal Ag-Pb-Zn-(Au) deposit discovered in 2005 by Bear Creek Mining Corporation. The deposit lies at the western limits of the late Oligocene-Miocene Ag-Sn trend extending from northwestern Argentina, through Bolivia and terminating in southeastern Peru. Corani currently contains Proven + Probable reserves totaling 258 million ounces of silver, plus significant lead and zinc by-products (Vector et al., 2009). On a silver equivalency basis, the reserve base plus resources reaches 719 Moz, establishing Corani as one of the largest undeveloped silver and base metal deposits in the world.

GEOLOGY

The district is divided into four principle areas of economic significance: Corani Main, Corani Minas, Corani Este and the Gold zone (Fig. 1c). Mineralization is emplaced into the Chacacuniza member of the Miocene Quenamari Formation which unconformably overlies the upper Palaeozoic sediments of the Ambo group (López, 1996). The host rocks are fortuitously exposed within a large erosional window through the younger, post-mineral ash fall tuffs. The window measures 4 by 7 kms in a north-south trend and is likely the result of doming resulting from (produced by) shallow, subvolcanic intrusive activity; relating to the mineralizing event and subsequent glaciation which removed the post-mineral tuffs, exposing the deposit. The three principle rock types in the project area are: the *basement units,* are a series of Palaeozoic (320 Ma approx.) shales with minor quartzites, sandstones and local carbonate lenses. This unit is moderately folded and faulted, striking NW with (and dipping) 10º to 50º dips east and west along the flanks of a moderate anticlinal fold. The basement rocks reportedly correlate with the Ambo Group (Klinck and Palacios et al., 1993; López, 1996); *Tertiary pre-mineral tuffs* (23.94 Ma +/- 0.15 Ma) hosting the mineralization are composed primarily of crystal-lithic tuff and crystal-vitric-lithic tuffs with quartz-eyes ranging from small, rounded to broken angular phenocrysts approaching 5 mm in diameter, accompanied by feldspar and often biotite. These units are generally hydrothermally altered, faulted, fractured, and brecciated. Beds strike northwest and dip sub-horizontally to 40º northeast. Age dating establishes that the host rocks correspond to the Quenamari Formation, Chacacuniza member (Chacacuniza Member of the Quenamari Formation). The pre-mineralization tuffs are capped by an angular unconformity with substantial topographic relief upon which lie the post-mineral volcanics. *The post-mineral tuff* (10.357 Ma +/- 0.080 Ma) represents the upper members (Sapanuta and Yapamayo) of the Quanamari Formation and consists of felsic crystal tuffs identical to the lower tuffs but effectively unaltered and barren. The post-mineral sequence forms prominent spires and thickens to the north (from 0 meters to over (more than) 200 meters in drill holes). These units are flat-lying to gently dipping and occupy much of the volcanic section at the north end of the concessions and extending (extends) at least 10 kilometers north. These units reportedly contain recently discovered uranium mineralization (autinite, metatorbenite metatorbernite) 30 kilometers distant (away) from the Corani deposit in the Macusani District.

STRUCTURAL GEOLOGY AND MINERALIZATION

The Corani ore bodies are hosted within a stacked sequence of listric normal faults striking dominantly north to north-northwest with moderate to shallow (50º to <10º) westerly dips. The hanging walls of the listric faults are extensively fractured and brecciated, forming ideal sites for metal deposition. The stacked listric faults are more prominent in Minas and Main with Este showing a single listric fault with an extensively fractured and brecciated hanging wall.

Mineralization outcropping at surface is generally associated with iron oxides, barite, and silica. Silicification is both pervasive and structurally controlled along veins. In drill core, the Corani deposit reflects a typical low-sulfidation silver, lead and zinc mineral assemblage. The most abundant silver-bearing mineral is fine-grained argentian tetrahedrite, or freibergite (Hazen Research, 2006; Gunning et al., 2007). Other minor sources of silver are acanthite and one or more members of the lead-silver sulfosalt group such as adorite (andorite)and diaphorite. Other sulfides include pyrite-marcasite, boulangerite (a lead antimony sulfosalt), sphalerite, galena and tetraedrita (tetrahedrite). Boulangerite and galena do not appear to be significant sources of silver. Zinc mineralization in the form of sphalerite (mainly high Fe type) overlaps the silver mineralization but can be more extensive, particularly in the Minas area where zinc mineralization extends ten's of meters to 100 meters beneath and lateral to the silver mineralization. Importantly, lead also occurs as plumbogummite, a lead-aluminum phosphate. Lead mineral speciation is dependent on pH and the plumbogummite is believed to be secondary in origin formed as a result of the remobilization of lead in the presence of phosphate in a very acidic environment plus a strong presence of aluminum. Plumbogummite is estimated to represent 14% of the lead in the total mineralized resource and, because of its adverse effect on flotation recoveries, plumbogummite's distribution is important to understand (to be understood).

GEO-METALLURGICAL BEHAVIOR

One of the key elements in unlocking the economic value of the Corani deposit was to understand the distribution and metallurgical response of the different mineralogical assemblages. The process of identifying the geo-metallurgical behavior of the deposit progressed on two fronts during the early years of exploration. First, it involved metallurgical test work to determine how the different materials responded to conventional recovery techniques such as flotation and cyanide leaching. The second step involved characterizing the ore geologically using both microscope and hand sample studies. Of particular importance to the geological understanding (of mineral distribution) was the extensive use of the QEMSCAN mineral identification tool (Gunning et al., 2007). With the help of QEMSCAN, specific mineralization styles have been identified and each displays (each displaying) different metallurgical characteristics (Corbett, 2007; Vector et al., 2009). These styles include:

Coarse silica-sulfide-celadonite (CSC) as the main ore type as (with) discernible galena-sphalerite, locally (associated?) with celadonite-tetrahedrite.

Coarse sulfide (CS) as a subset of CSC that contains galena-sphalerite-chalcopyrite ± tetrahedrite without green celadonite clay (mica).

Freibergite/ Ag-Tetrahedrite (TET) ores are characterized by recognizable late stage coarse-grained tetrahedrite which crosscut earlier sulfides and display the highest Ag contents.

Pyrite-marcasite (PM) ± quartz mineralization occurs in the lower parts of the deposit and usually contains little Ag-Pb mineralization but may contain minor disseminated Zn mineralization.

Fine black silica-sulfide (FBS) represents very fine-grained rapidly cooled (quenched) ore fluid with highly variable metal contents.

Crystalline quartz-sulfide ± barite (QSB) which is interpreted as early fault fill and although galena-bearing is only well-mineralized when cut by later tetrahedrite-bearing fractures. These veins may be transitional to the Au-bearing quartz-pyrite veins in southern Corani.

Plumbogummite (PG), identified as a pale-green, waxy, Pb phosphate mineral that shows diminished lead flotation and difficulties in separation of base metals in metallurgical testing.

Iron-oxide mineralization (FeO) with locally elevated Ag and generally low Pb-Zn. This is a gradation zone containing mixtures of FeO and FBS.

Manganese oxides (MnO) occur as (bearing) mainly Ag but also Pb-Zn (as adsorbed cations). within Mn .

METALLURGICAL RESPONSE

The ore body was originally characterized into five separate metallurgical types based solely on how each material responded to flotation and cyanide leaching recovery methods. Consequently, it was possible to combine several of the mineralization styles described above. The description of each type is shown in Table 1. Later optimization metallurgical test work showed that the predominant sulfide ore types (Type I and II), which constitute 86% of the ore tonnes (tonnage), respond to flotation in a similar manner producing separate lead and zinc concentrates. The Type III material represents the transitional ore and is a mixture of oxides and sulfides. The Type IV material represents the oxide portion of the deposit and has been subdivided into manganese rich and manganese poor areas. Both of these oxide types do not respond well to flotation recovery methods. However, the manganese-poor material responds well to cyanide leaching and the manganese-rich material responds poorly to cyanide leaching.

CONCLUSIONS

The Corani District represents a recently discovered, highly endowed precious and base metals system. Drilling to date has intersected continuous intervals ranging from 50 to over 100 meters thick averaging from 30 g/t to 150 g/t silver indicating a very robust hydrothermal system emplaced within structurally prepared, receptive host rocks. Mineralization remains open, particularly under post-mineral volcanic units thickening towards the north and the potential for discovery of “blind” deposits is high. While a great deal remains to be learned regarding its geologic setting and genesis, several key factors have been defined which will continue to assist in the exploration and development of this and (the) surrounding districts. Geo-metallurgical understanding of the deposit was key in unlocking (its) the economic potential of the deposit. The distribution of the different metallurgical zones of material is consistent with observations regarding the geology, alteration and oxidation of the deposit. It is fortunate that the erosion on the central parts of the Minas and Este zones has effectively pre-stripped the post-mineral tuff and more marginal metallurgical materials, exposing the highest-grade material with the best metallurgical behavior for the early years of the future mine’s (mine) operation.

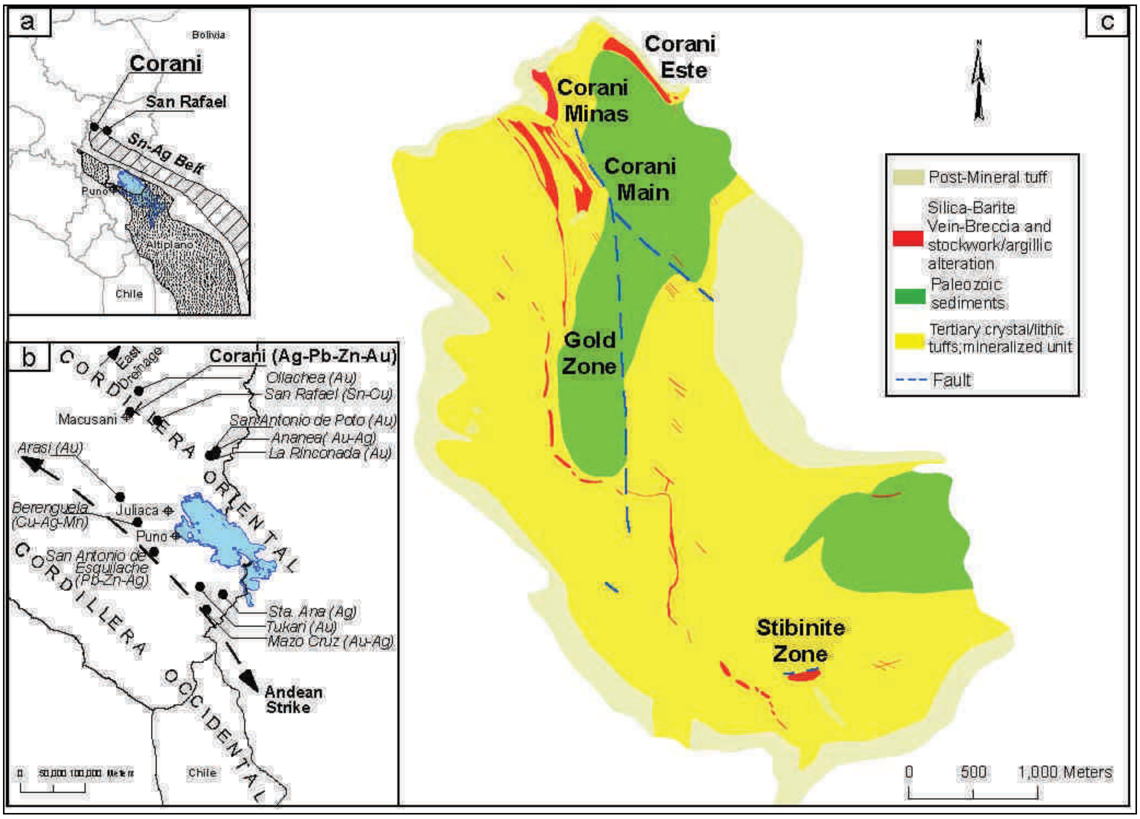

Figure 1. Location of the Corani deposit.

Table 1. Metallurgical Types.

METALLURGICAL TYPE	FLOTATION RESPONSE	PB/ZN SEPARATION	CYANIDE LEACH RESPONSE	GENERAL MINERALOGY/PREDOMINANT ORE TYPE	OCCURRENCE
Type I	Very Good	Good	Poor	Coarse Sulfides – CSC, Tet CS	Sulphide section of East Minas, Central Este and East Main
Type II	Good	Good only with flotation extenders (EDO)	Poor	Fine Sulphides – FBS, PM, QSB	Sulphide sections of all deposits
Type III	Diminished	Not relevant since generally low in zinc	Poor	Mixed Fe oxide and sulfide – FBS, FeO, PM, Pg (PG)	Oxide sections of Este, East Minas and East Main
Type IV-Leach	Poor	Poor	Good	Mixed Fe oxide and sulfide – FeO, FBS, QSB, Pg (PG)	West Minas, West Main and Este Minas connection
Type IV-No Leach	Very Poor	Poor	Poor	Oxides with high amounts of Mn oxide – MnO, FeO	Limited parts of West Minas

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