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GEOLOGY AND GEOCHEMISTRY OF THE COLLIGUAY GOLD DISTRICT, CENTRAL COASTAL CORDILLERA, CHILE

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INTRODUCTION

The results of a geological and geochemical survey of the Colliguay district, located in the V region of Chile, approximately 90 km NW of Santiago, at 800 m altitude, are advanced. Mapping of geology, structure, alteration and mineralization, and widespread geochemical sampling was completed in the prospect. In addition, an orientation Enzyme Leach survey of the most promissing targets was done. The types of alteration, mineralization and geochemical distributions, all within the geological-structural setting, were used for metallogenic modelling and exploration potential assessment.

GEOLOGY

A probable Lower Cretaceous porphyry system is emplaced within an Upper Jurassic felsic volcanic and subvolcanic rock complex (IVC) in the Colliguay area. These rocks occur within the Upper Jurassic - Lower Cretaceous pluto-magmatic arc of the Andes of central Chile, composed by volcanic and marine sedimentary rocks, intruded by Lower Cretaceous granitoid and andesitic porphyry stocks.

At least three main intrusive facies compose the Colliguay porphyry system: the Colliguay porphyry; andesitic dikes and sills, and a granodioritic stock which underlies most of the district. The time-relation among these facies is unclear, but suspected mostly cogenetic.

A series of NE-trending faults inferred to be part of a dextral strike-slip system occurs in the area.

ALTERATION AND MINERALIZATION

In the Colliguay area, widespread hydrothermal alteration and gold-silver mineralization affect both the IVC and porphyry rocks, along the trend of the main fault system, covering approximately 13 km^2. Alteration consists of quartz-sericite-pyrite in the IVC rocks, and quartz-sericite-chlorite-pyrite in the Colliguay porphyry. Both alteration types are associated with quartz-pyrite stockwork. At surface levels, strong supergene argillic alteration overprints the previously described alteration assemblages.

Known mineralization present within the regional Upper Jurassic - Lower Cretaceous plutono-volcanic arc rocks consists of gold-silver mesothermal vein and skarn deposits such as Alhue and Cerro La Campana and stratabound copper deposits such as Lo Aguirre and El Soldado.

GEOCHEMISTRY

A total of 414 rock chip samples (2-3 Kg each) were collected in the Colliguay district for geochemistry and to assess exploration potential. All samples were analyzed for Au by a 50 g fire assay technique (FAA), and 363 samples were analyzed for 30 elements by inductively coupled plasma atomic emission spectrometry (ICP-AES). For ICP-AES, a 0.5 g subsample was digested by a 3:1:2 HCl-HNO_3-H_2O leach at 95°C for one hour, then diluted to 10 ml with water.

Precision and accuracy was determined by repeated analysis of duplicate and standard samples, respectively. Statistical analysis of results indicates precision within a 90% confidence level, and accuracy above a 95% level.

ELEMENT CONCENTRATIONS

Geochemical results (Mo, Cu, Pb, Zn, Ag, Au, Bi, As, Sb and Ba) of the Colliguay district were treated by statistical population analysis (Lepeltier, 1969) with software PROBPLOT (PPLOT v.1.07 E7, Stanley, 1987). Populations calculated for each element were compared to global geochemical contents of intermediate igneous rocks (Table 1), and exploration threshold values are defined based on population limit values above normal global contents. In addition, positively anomalous populations are divided into two categories, anomalous and highly anomalous, depending on contrast with respect to threshold value and global background. Table 1 summarizes a three population analysis for all elements and the normal contents of these in intermediate igneous rocks (andesite-granodiorite). In addition, column 5 shows the total percentage of anomalous samples, and the exploration threshold value is suggested as the anomalous - background limit.

Table 1. Results of statistical population analysis (PPLOT v. 1.07, Stanley, 1987) and comparison with global value ranges for intermediate composition igneous rocks

Elem.*	Normal global content [ppm] **	Background population [ppm]	Anomalous population [ppm]	Highly anomalous population [ppm]	Percentage of anomalous samples
Mo	1 - 1.5	< 6	6 - 19	> 19	30
Cu	30 - 72	< 85	85 - 670	> 670	31
Pb	4 - 15	< 32	32 - 3890	> 3890	22
Zn	60 - 94	< 110	110 - 1470	> 1470	21
Ag	0.07 - 0.1	< 0.5	0.5 - 8.8	> 8.8	13
Au	0.003 -0.004	< 0.03	0.03 - 0.189	> 189	28
Ba	250 - 500	< 300	300 - 514	> 514	16
Bi	0.1 - 0.15	< 5	5 - 12	> 12	18
As	1.5 - 2	< 25	25 - 67	> 67	24
Sb	0.1 - 0.2	< 4	4 - 8	> 8	7

** Element. Number of samples included in statistical study are 363, except Au, 414.*
*** Global value ranges compiled from the following references: Turekian and Wedepohl, 1961; Wedepohl, 1969; Wedepohl, 1969-1978; Levinson, 1974; Turekian, 1977; Saager et al., 1982.*

ANALYSIS OF ELEMENTAL DATA

To investigate the inter-relation of elements in the Colliguay district a Pearson product-moment correlation matrix for logarithmically transformed data was calculated and, in addition, a factor analysis was done. Results show good correlation amongst Mo-As-Sb-Bi, with lesser correlation with Pb and Ag. A five factor model explains over 85% of variance, and factor loadings indicate: i) tight grouping for Mo-As-Sb-Bi and lesser Ag for factor 1; ii) Ba dominates factor 2, with a lesser contribution of Ag and Pb, negative with respect to other elements; iii) Zn dominates factor 3, with a small contribution of Ag and Pb, negative with respect to other elements; iv) Cu dominates factor 4, with lesser Ag, and v) Au stands alone in factor 5.

ELEMENT DISTRIBUTION AND TARGET POTENTIAL

Anomalous areas are plotted in Figure 1, which shows four main target areas with different potentials: i) Cerro El Durazno, marked by anomalous Zn and As, and lesser Pb, covering and area of 0.8 Km^2 of silicified limestones with minor sulphide mineralization; ii) Cerro Blanco, marked by anomalous Mo, Pb, Zn, Ag, As, Bi, and lesser Cu, covering an area of 0.6 Km^2 of volcanic hosted manto-like barite-quartz-pyrite mineralization; iii) Cerro Vizcaino, marked by anomalous Pb, Ag, Au, As, Bi, and lesser Cu, covering an area of 1 Km^2 of hydrothermal and collapse breccia mineralization, and iv) Tirillenta, marked only by anomalous Au, As, and lesser Cu, covering an area of 0.5 Km^2 of quartz-pyrite matrix vein breccia mineralization.

ENZYME LEACH GEOCHEMISTRY

One NW-SE 3 Km long sample line, with 100 m sample intervals was taken for an Enzyme Leach orientation survey of the most significant target areas (Tirillenta and Vizcaino; Fig. 1). Enzyme Leach analysis were done at ACTLABS laboratories, Canada. Results show a marked oxidation halo anomaly (Br, I, Cl) which delimits the northern Colliguay porphyry - granodioritic stock contact, and is interpreted to represent the same southern contact beneath the IVC volcanics. The northen Br, I and Cl low also marks the Tirillenta vein. In addition, important central peak anomalies (Cu, Zn, Pb, Cd, Mo) are observed in the Vizcaino target, symetrically centered with respect to the underlying Colliguay porphyry.

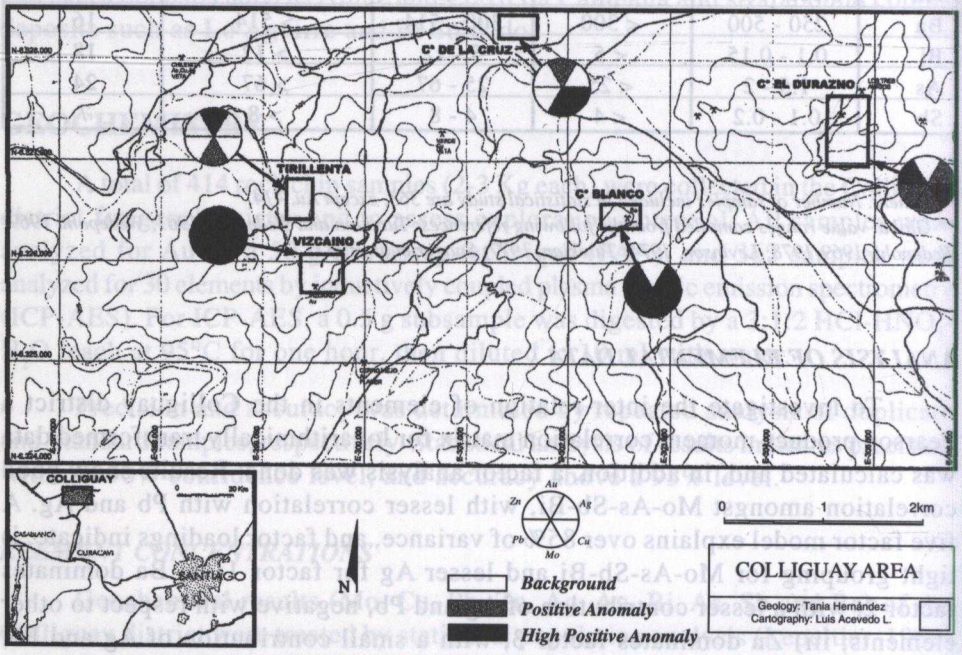

Figure 1. Location and geochemically anomalous targets of the Colliguay district. The Enzyme leach line was taken from Tirillenta to just south of the Cerro Viejo Placer

DISCUSSION

The Colliguay prospect holds potential for structurally controlled Au-Ag and Au mineralization. Quartz-sericite-chlorite-pyrite alteration observed in the Colliguay porphyry, with quartz-sericite alteration of the overlying IVC volcanics, is quite characteristic of the pyritic halo zone of mineralized porphyry systems. Small vein or breccia ore bodies are not uncommon within the pyritic halo, in this case represented by the Tirillenta vein and the Vizcaino breccia. Enzyme Leach geochemistry outlines the northern and southern limit of the Colliguay porphyry, and centers sulphide mineralization potential symetrically within the

porphyry. Gold mineralization, as indicated by the correlation and factor analysis, occurs independent with respect to any other elements, and may be found associated with other metals (e.g. Vizcaino breccia) or may be found as single mineralization (e.g. Tirillenta breccia vein). Widespread alteration and gold mineralization within the Colliguay porphyry, together with Enzyme Leach evidence of sulphide oxidation, suggest a large porphyry hosted mineralized body may exist at depth, within the Vizcaino - Tirillenta area, whether there could be gold dissemination or not can only be tested by drilling.

Alteration, mineralization and geochemical signature of the Colliguay porphyry and related upper vein and breccia mineralization are comparable to gold-rich porphyry systems such as those present in the southern Maricunga belt, Chile (Vila and Sillitoe, 1991).

CONCLUSION AND COMMENTS

Based on geology, alteration, mineralization and geochemistry, this prospect may be comparable to the upper zones of Andean gold rich porphyry systems, suggesting the possibility for a large volume, low grade Au deposit at depth. Despite the long exploration history of this district, the small scale mining and the large area of hydrothermal alteration, no deep drilling campaign has been carried out so far. The deepest drill holes located within the Vizcaino breccia, no deeper than 160 m, were intended only for ore reserve assesment of the Vizcaino orebody. Some of these drill holes bottomed out in the Colliguay porphyry, within the pyritic halo, confirming the presence of this porphyry at depth.

Despite that gold porphyry type mineralization has never been reported within the central Upper Jurassic - Lower Cretaceous pluto-volcanic arc, mesothermal gold-rich vein mineralization is reported both north and south of the Colliguay district, together with abundant placer gold deposits, indicating the existence of gold mineralization potential within these arc rocks. In addition, farther north in Andacollo, a Cretaceous porphyry copper deposit with peripheral adularia-sericite related gold mineralization occurs.

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