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Geology of the Quilmenco Valley, scale 1: 10,000 and evaluation of the Cu-Au mineralization potential. Supporting Background for Condemnation of the sector. Choapa Province, Coquimbo Region, Chile.

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Summary.

Sociedad Contractual Minera Tres Valles, owner of the Papomono and Don Gabriel deposits, had the need to evaluate sectors of the Quilmenco Valley, in which there are optimal geomorphological conditions for the location of the SXEW processing plant, leaching piles and infrastructure . The decision regarding the final location of these facilities was accompanied by geological antecedents that allowed condemning these strategic locations for the company.

This study provides the antecedents and results obtained with the 1: 10,000 geological mapping of the Quilmenco Valley, with emphasis on the evaluation of the economic potential of the area.

In the context of this work, all the lithological units recognized, the predominant structural trends are described and all the manifestations of mineralization in the valley environment are evaluated, defining two mineralized systems: minor quartz veins with low power gold-copper mineralization and Small-scale copper mineralization associated with andesitic rocks, similar to what is recognized 15 km to the east in the Don Gabriel Mine, Type Estroligado (López, JM, 2010).

The surface mapping work is accompanied by the results of petrography-intaglio, rock geochemistry (ICP-Atomic Absorption), TEM geophysics and diamond drilling.

Keywords: *Quilmenco Valley, condemnation, diamond drilling, TEM geophysics, AuCu veins, stratoliginated deposits.*

1. Introduction

1.1 Location.

The study area is located in the IV Region of Coquimbo in the Province of Choapa, Commune of Salamanca. It is located 196 km NNW of the city of Santiago and just 8 km NW of the city of Salamanca (Figure 1).

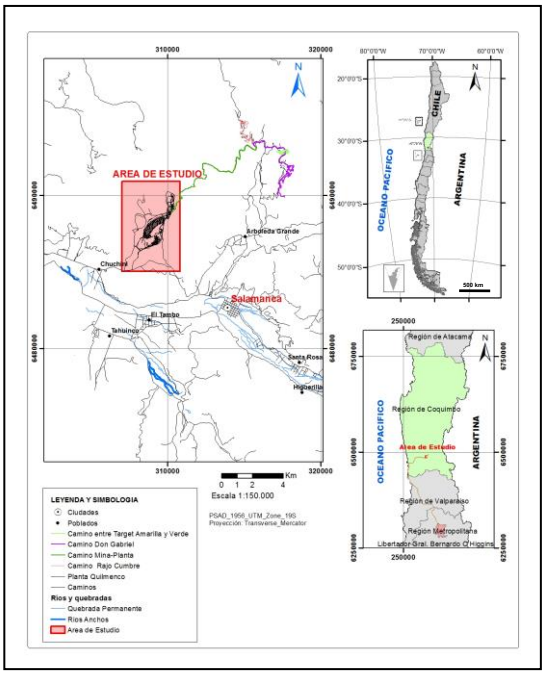


Figure 1. Study area location.

1.2 General Objective.

The objective is to deliver the geological evaluation of the study area, with an emphasis on mineralization potentials. To conclude in this way, with the condemnation process of the strategic areas, necessary for the construction of the processing plant and leaching heaps of the Tres Valles Minera SCM.

1.3 Specific Objectives.

- The main specific objective is the gathering of the greatest amount of information in the field geological in detail (lithology, structures, etc.), which allow the construction of the geological base 1: 10,000 of the sector.

- Detailed survey of all areas with the presence of mineralization. Identification of the domains (gold, gold-copper, copper, etc.) and their real potential in the study area.

- Proposal and execution of a diamond drilling campaign for condemnation, in the area defined for the facilities. Evaluation of results and definition regarding the condemnation of the area.

1.4 Acknowledgments.

We are grateful to Sociedad Contractual Minera Tres Valles (during the administration of Compañía Minera Vale) for authorizing the collection and publication of the information obtained and for financing the studies carried out to a great extent.

2. Geological Framework

The different lithological units recognized in the study area are part of the Lower to Upper Cretaceous geology that define the geological environment of the Choapa Valley. In the study area recognize rocks volcano sedimentary belonging to the Quebrada Marquesa Formation (Barremiano - Albiano Lower Cretaceous?) instructed by the batholith of the Chalinga Unit belonging to the Lower Cretaceous Illapel Super Unit (Rivano and Sepúlveda 1991), the most important structural feature is the Manquehua Fault in direction NNW, located 5 km east. These authors define the package of volcanic rocks recognized in the sector as part of a roof pendant block hanging on the intrusive belonging to the Chalinga Unit (Figure 2).

3. Methodology

3.1 Cabinet Stage 1

Compilation Y harvest of material Public or internal bibliographic, related to the geology available in the study area.

3.2 Terrain Stage.

Stage of recognition and mapping of lithology, structures, mineralization and alteration present in the Quilmenco Valley environment. The final result of this stage is the preparation of a 1: 10,000 scale map, with emphasis on evaluation and sampling of all the mineralization manifestations recognized in the sector and definition of potential.

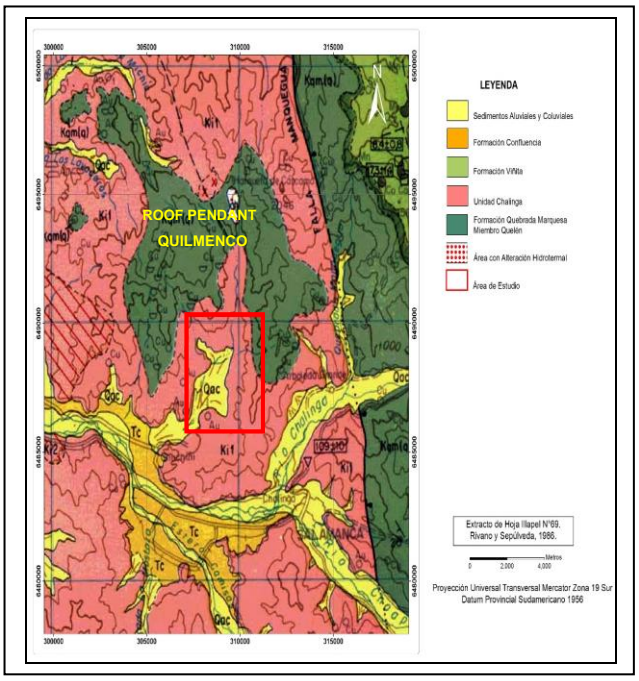


Figure 2. Illapel Leaf Extract 1: 100,000. Taken from Rivano and Sepúlveda (1986).

3.3 Laboratory Stage.

This stage includes the analytical process of the different samples of gutters and chips collected in veins and outcrops of the study area. 18 samples were analyzed with ICP and Fire Assay techniques to evaluate the presence of gold. These were made in the lab **ALS Chemex** based in Coquimbo. The result of 36 elements is reported for each sample (Table N ° 1). At **Laboratory of Compañía Minera Tres Valles,** The same 18 previous samples were processed by the Atomic Absorption (AA) technique, where the results of Total Copper and Sequential Copper (CuSol - CuSol H + - Insoluble Cu) were obtained. (Table N ° 2). Four petrographic and 3 chalcographic samples from the study sector were described (Figure 3 and Annex N ° 1). This study was executed by

3.4 Cabinet Stage 2.

All the information collected from the terrain is digitized, analyzed and integrated, for the generation of the Main Geological Map scale 1: 10,000 (Figure 3). At this stage, all the field data, laboratory, TEM geophysical studies and the information recovered from the diamond core drilling campaigns were incorporated.

4. Collection of terrain data, geophysics, sampling and drilling.

Next, the data obtained from the 1: 10,000 detail mapping are delivered.

4.1.- Lithology.

The mapping of the units around the Quilmenco Valley allows the identification of an intrusion contact zone between rocks of the Quebrada Marquesa Formation with intrusive rocks of the Batholith of the Chalinga Unit belonging to the Illapel Super Unit. This contact crosses the entire central part and has an irregular NS to NNE-SSW orientation, an average width of 200 m (Figure 3). Next, the data collected in each unit recognized in the field is delivered.

Quebrada Marquesa Formation (Aguirre and Egert, 1962). The Training Broken Marquise corresponds to the basement lithological unit in the study area and is mainly distributed towards the western slope of the Quilmenco Valley (Figure 3). The outcrops cover an area of 5 km two. This volcanic sequence has a disposition between N10 ° -15 ° W / 20 ° NE for the Cecilia Sector, while in the Esperanza and Cerro Las Cortaderas Mining Sector it is N5 ° -10 ° E / 25 ° -35 ° SE. The lithology corresponds to andesites, tuffs and andesitic volcanic breccias with varying shades between gray-green to reddish-brown. Towards the westernmost sector of the area, around Cerro Las Cortaderas, the volcanic sequence is distributed in a north-south strip, where the Andesites dominate. Towards the northern sector in the Esperanza Mine, andesites with porphyritic texture and abundant vesicles are observed; and andesitic gap levels

interspersed. These rocks are Correlated with the Upper Member “Quelén” belonging to the Quebrada Marquesa Formation, defined by Rivano and Sepúlveda, 1991. The age of these rocks is Lower Cretaceous (Barremian-Albanian?).

Porphyry andesites, breccia andesites, andesitic breccias and some levels of tuff belonging to the Quebrada Marquesa Formation predominate in the Cecilia Sector and in the north-central contact strip of the area. These units are strongly affected by the area of contact with the Chalinga Intrusive Unit. In this contact zone, strong alteration is observed, where pervasive silicification predominates, locally with a banded texture (Photo 1),

moderate to strong argilization and limonites-hematite. This halo extends in a NS direction, attached to the contact of the intrusive, affecting the volcanic rocks.

Photograph 1. Andesitic rocks with intense silicification. Striped texture in contact halo.

Illapel Super Unit, Chalinga Unit.

The Illapel Super Unit was defined by Rivano *et al.,* 1985. It is characterized by being the most important intrusive set in the Illapel Sheet. The rocks in this sector are included in the intrusive rocks that are part of the Chalinga Unit belonging to Pluto Illapel-Caimanes. The intrusives of this unit are mainly distributed towards the eastern and southern slopes of the Quilmenco Valley and to a lesser extent on the western slope, towards the Cecilia Sector. They cover an area of 5.7 km two

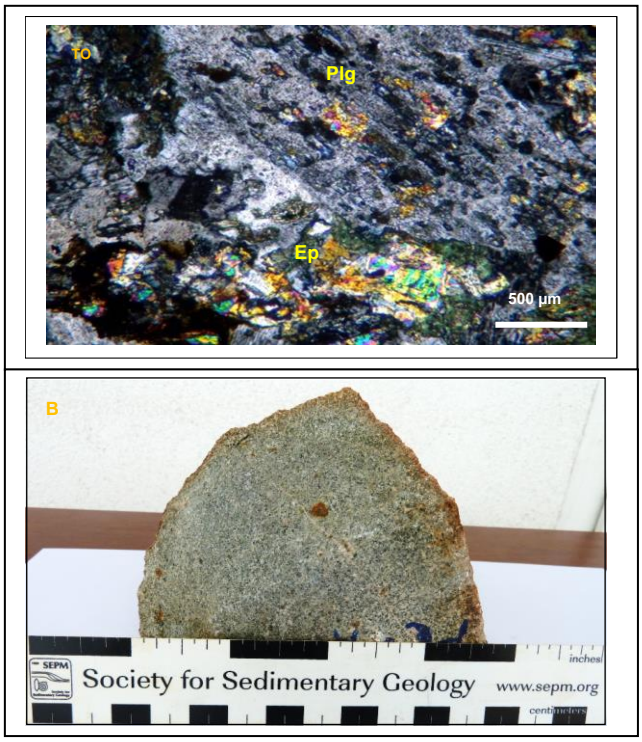
(Figure 3).

The evidence on the ground shows that to the north, in the Cecilia sector, this unit is intruding into the Quebrada Marquesa Formation and to the south this contact is covered by unconsolidated Quaternary Deposits.

The lithology corresponds to microdioritic rocks and to a lesser extent light gray monzodiorites, which present a color index that characterizes them as leukocratic, with weak alteration to clays and epidote, a situation confirmed with the petrographic studies carried out by Holmgren, 2013 (Photo 2A YB).

In the present study, no radiometric dating has been carried out, there is only one Pb-α dating in an intrusive of this unit, located 3.5 km SE of the study area and giving an age of 109 ± 10 Ma (Munizaga, 1972). With this background it is coherent to propose a

Relative age for this intrusive unit from the Lower Cretaceous (Albian?).



Photograph 2. A. Argilized plagioclase (Plg), diffuse twins, relic ferromagnesian interstices, with epidote (Ep), opaque and malachite. Crossed Nicoles, increased by 40 times. B.- Hand sample, microdiorite from the Portería sector.

Minor Microdioritic Intrusives.

The definition of this unit is informally proposed in this study. These smaller intrusive microdiorite bodies are clearly distinguishable in ground Y appear overriding the main intrusive unit. Rivano and Sepúlveda, 1986, only indicate the existence of intrusives related to the Chalinga Unit for this area and incorporate all the types of intrusives present within this unit. In this study it is proposed to differentiate these Minor Microdioritic Intrusives in a different unit, even with the possibility that they are part of the same Chalinga Unit. This proposal is supported, in the evident presence of clear contacts, well-defined location, characteristics compositional, mineralogical and temporality characteristics, which make it something perfectly mappable and differentiable at a scale of 1: 10,000 (Figure 3). These intrusives are mainly distributed in the central sector, around the axis of contact between the Chalinga Unit and the Quebrada Marquesa Formation. They recognize outcrops in the Cecilia Sector, Monte La Tenca and Centro-Sur. They cover a total area of 0.70 km two.

The recognized contact relationships show that these bodies appear to intrude both the Quebrada Marquesa Formation and the Chalinga Unit. Towards the western slope of the Quilmenco Valley in the Monte La Tenca and Centro-Sur sectors the bodies are mainly sub-rounded, while towards the Cecilia sector they have elongated shapes in the NW-SE direction. The recognized outcrops correspond to greenish-gray to dark gray microdioritic rocks, that is to say, with darker tones than the leucocratic microdiorites belonging to the Chalinga Unit. This condition is the product of the greater amount of ferromagnesian minerals (biotite, amphiboles and pyroxenes) in its primary composition. There are no radiometric dates for this unit, only by contact relationships it can be inferred that they are later than the Lower Cretaceous Chalinga Unit.

4.2.-Structural Geology.

An interpretive analysis was performed on the IKONOS Satellite Image of the major structural domains identified in the study area. A classification of these is delivered based on their main addresses. Its relationship with orocobre mineralization events, with lithological units and control in geographical features recognized in the field is detailed (Figure 4

A, B and C). The information collected in the vein or outcropping sectors was relevant to contribute to the definition and recognition of the different domains presented in this chapter.

3 preferential directions are recognized:

NS domain: Two main lineaments are identified that cross the study area in the central part and appear to clearly delimit the western and eastern slopes of the Quilmenco Valley esplanade in its wider area (Figure 4A,

C). These guidelines are parallel to the major faults what dominate districtly Y what correspond to the Manquehua and Llimpo faults (Veliz, 2007). The NS lineament of the eastern side clearly coincides with the contact zone of the Chalinga Unit with volcanic rocks to the north and controls the location of some minor veins. The NS guideline of the western side, appears controlling geographic features in the sector

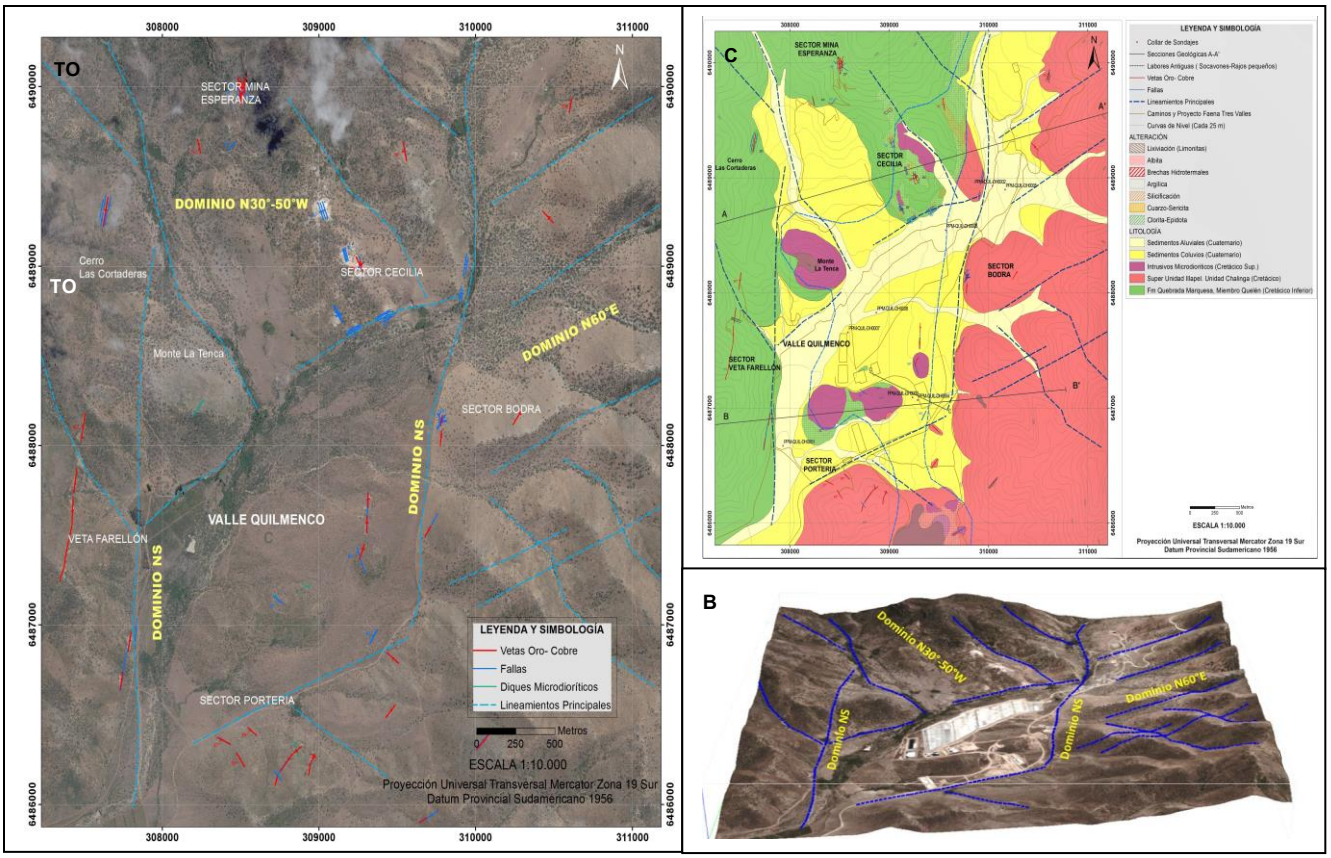


Figure 4. Structural Model of the study area. TO- Interpretation of structural domains in ICONS image. **B.-** Interpretation structural presented in 3D model. **C.-** 1: 10,000 scale geological map incorporates recognized structural domains.

del Monte La Tenca and important NS-N10 ° E veins such as the Farellón Vein are also observed, with copper-gold mineralization associated with this domain.

Domain N60 ° E: It is identified in the central and eastern sector of the study area. In the central part, the two main NS lineaments are intercepted and connected, which shapes a rhombus that clearly coincides with the central depression of the Quilmenco Valley (Figure 4A).

Based on this interpretation, it can be assumed as a hypothesis, a possible Distensive Type kinematics (Cembrano, 2001), caused by heading faults with dextral displacement, which gives rise to a "Duplex Type" architecture for the study area. Numerous lineaments of this domain, are recognized towards the eastern sector, control the directions of the numerous streams and also the location of some small veins with gold mineralization in the southern sector.

Domain N30 ° -50 ° W: These guidelines are they clearly observe from the Quilmenco Valley towards the north-western sector and are mainly controlling geographic features (eg ravines). Its preferred direction is N30 ° W (Figure 4 AC). In the Cecilia Sector, this lineament has a very marked N30 ° W direction, where faults and strong fracturing have been mapped parallel to this direction, in addition to hydrothermal alteration associated with mineralization of small-expression quartz veins without the presence of gold and copper. In the Porter Sector, structures related to these major guidelines can also be observed, although the trend is N50 ° W. They correspond to areas of weakness (minor faults) where small gold-copper veins associated with crystalline quartz are located,

Similar to systems of veins mineralized with gold, described in El Espino District (Cembrano, 2008).

4.3.- Economic geology and potential of exploration.

In the surroundings of the Quilmenco Valley, vein systems with gold, gold-copper mineralization have been identified, as well as vein and mantle systems with only copper mineralization. These occurrences correspond to minor events, with veins that locally reach powers of one meter and little

run. The most important vein that has been exploited at the artisanal level corresponds to **The Farellón Vein** which has a 900m run and very locally reaches powers of 1m, on the surface. In this study, 4 sectors with alteration and mineralization of interest have been detected and evaluated (Annex N ° 1). They are described below:

Goalkeeping Sector: It is located in the central southern part of the study area and is characterized by the presence of numerous small veins, exploited at an artisanal level in the eighties (Magma Gelogos Consultores, 1981). The evaluation of these in the field indicates that there are two different groups, according to their disposition: a group of veins at N10 ° -55 ° E / 90 ° located to the east of the zone and the others with provisions N35 ° -65 ° W / 57 ° -65 ° SW west of the area. The runs of these vary from a few meters to 250 m and the powers fluctuate from a few centimeters to a maximum of 1.0 m. The mineralization is characterized by massive, locally crystalline quartz, which houses lower concentrations of gold, related to pulverulent reddish hematite and limonites. In addition, they contain copper mineralization: chrysocolla, malachite, copperwad and limonites.

Several of these veins were sampled for chemical analysis. The analytical procedure used to evaluate each of the samples in this study was as follows: First, a sweep was carried out with an ICP analysis where results were obtained for 36 elements, at this stage the analysis with fire test is also included for identify the presence of gold (Table N ° 1).

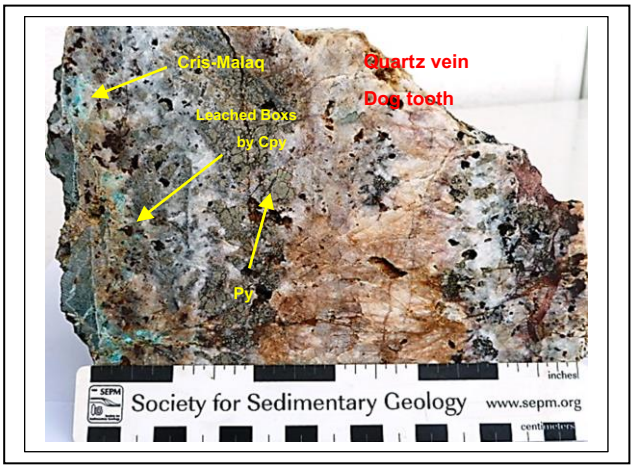
In a second stage, the same samples were evaluated by Atomic Absorption (AA) in order to precisely obtain copper results that have over-limit values in ICP tests. At this stage, it was also possible to identify the concentrations of copper that solubilize in different media (soluble in sulfuric acid, in sodium cyanide and multi-acid digestion). These analyzes were made in the internal laboratory of Faena Tres Valles, Salamanca (Table N ° 2). The results for the veins in this sector are given below: 1. There is only one anomalous gold value of 0.134 ppm. 2. Copper concentrations fluctuate between 0.22% -

1.23% Cu Total. 3. The dominant copper species are found in an oxidation environment, since the results of S (sulfur) are very low

concentrations 4. In all the samples there are low to moderate concentrations of insoluble copper (0.10- 0.46% Cu Insol), coming from insoluble species in oxidation environments, such as: copperwad. It is concluded that the copper mineralization potential is more important than that of gold for the Porter Sector and that it is marginal for the interests of the company.

Veta Farellón Sector: It is located in the westernmost sector of the study area and corresponds to an important vein, which had strong gold extraction activity at the artisanal level. The main layout ranges from NS to N10 ° E with 80 ° NW-90 ° angles. The run is approximately 900 m and the powers recognized on the surface are variable, from a few centimeters to a maximum

1.10 m. The mineralization event is characterized by veins of whitish quartz with “dog's teeth” type crystals accompanied by abundant sulfides, where pyrite and chalcopyrite predominate as the primary event, chalcosine as a secondary enrichment product; and chrysocolla, malachite and brochantite as a result of the oxidation of the sulfur phases (Photo 3).



Photograph 3. Veta Farellón. Abundant textured quartz "Dog tooth". Pyrite, chalcopyrite boxworks and little presence of limonites, malachite and chrysocolla.

Two samples were taken in the Farellón Vein, one of selected material collected by the former miners who left the area and the second, a sample of the gutter in the surface vein. The results obtained indicate:

1. The gold grade for the chosen material is 8.97 gr / ton. 2. The gold grades of gutters in the two surface sectors in the vein are of the order of 1 gr / ton. 3. High concentrations of copper

They are related to gold and reach variable values between 1.16% - 3.35% Total Cu. 4. High concentrations of copper in Atomic Absorption (AA) are composed of 60% in the oxidized or leachable phase (chrysocolla malachite, brochantite), 7% of cyanurable minerals (chalcosine, digenite or covelin) and 33% of insoluble minerals (chalcopyrite).

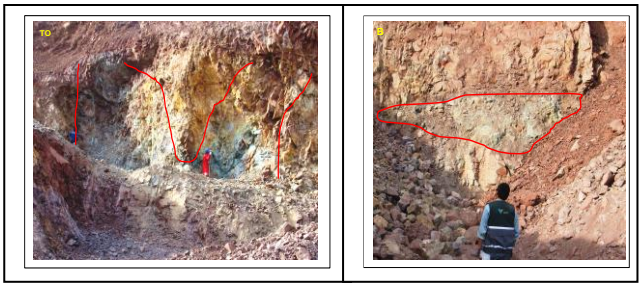
It is concluded that the Farellón Vein has characteristics of gold-copper mineralization of good grade for artisanal activity (1 gr / ton - 1% Cu Total). The exploitation of this, must necessarily incorporate the process of selection of the material, in order to achieve better sales laws (8.97 gr / ton-

3.35% Cu Total). The evaluation of the potential indicates that the gold-copper resource is strictly confined to the thin vein (<1m) and with a not very receptive box rock (compact porphyry andesite). It is also important to note that the mining property of this vein belongs to another owner. It is concluded that the gold-copper mineralization potential for La Veta Farellón is marginal to the interests and scale of production of the company.

Esperanza Sector: It is located in the NNW sector of the study area, it corresponds to a sector with copper veins and mantles, which were exploited by artisanal miners in quarry-type work.

Veins: The main arrangement is N10 ° -30 ° W / 90 °, there are other minor veins with a NW arrangement, which converge to this main trend. The observed power is of the order of 3-5 m. The box rock is porphyry andesite with a coarse, amygdaloidal texture. The mineralization is defined by the occurrence of chrysocolla, brochantite, azurite, copperwad, little malachite, cuprite and copper-rich limonites, as well as little chalcosine and covelin, as secondary enrichment products of the original ore (Photo 4A).

Cloaks: The arrangement is irregular and subparallel to the N10 ° E / 25 ° SE stratification and reaches powers of up to 3.0 m (Photo 4B). The host rock corresponds to a thick amygdaloidal porphyritic andesite. Mineralization is defined by oxidation environment copper minerals such as chrysocolla, brochantite, copperwad, scant malachite, and copper-rich limonites. The type of occurrence is in fractures and filling in tonsils. The Esperanza Mine was evaluated by means of gutter samples for the vein, and of the chip type, for the mantles. The results obtained indicate:



Photograph 4. A. Quarry with the exploitation of mineralization of copper with vein type arrangement. B. Small quarry, with exploitation of copper mineralization with mantle-type bodies (N10 ° E / 25 ° SE).

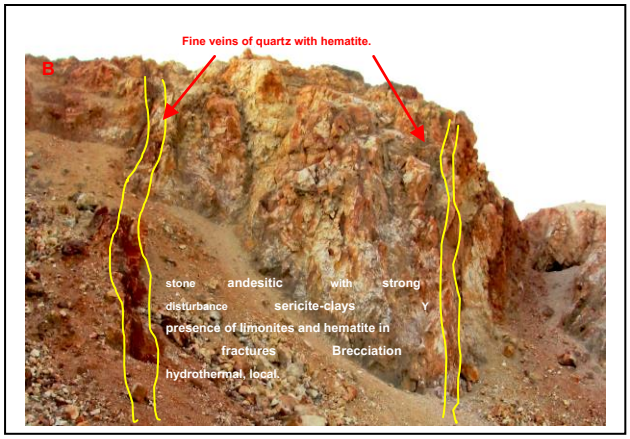
1. Gold concentrations do not have any interest value. 2. The copper grades obtained in the AA analysis indicate very high values, from 1.80% Total Cu to 5.79% Total Cu. 3. The high concentrations of copper are made up of 87% of the oxidized phase of copper minerals (chrysocolla, brochantite, malachite, azurite, etc.), 4% of secondary minerals (chalcosine, covelin) and 9% of insoluble minerals (copper wad or cuprite).

The mineralization recognized in the Esperanza Mine has exclusive mineralization characteristics of copper (> 1% Total Cu), where mineral species from the oxidation environment predominate. The characteristics of the mineralization, the results of the copper concentrations, the types of occurrence and the geological environment of the site,

would indicate similarities with characteristics already recognized in the Don Gabriel and Papomono deposits located between 9-15 km to the NEE, defined as Stratoligated CuAg Type Deposits (López, 2010). IP geophysics and borehole drilling campaigns would be recommended to assess potential at depth. This sector is owned by a small miner, with whom you should have approaches to explore the area.

Cecilia Sector: The area is located in the central-north sector of the valley and is characterized by a hydrothermal brecciation event (Hernández, 2007). It is closely related to a structural trend of N30 ° W, which has an elongation in that direction of 1.2 km and a width of 500 m. It is characterized by a strong presence of sericite-clays; moderate to weak amount of limonites-hematite and weak silicification. In this zone of hydrothermal alteration there is a 15 m quarry, where artisanal miners tried to explore or exploit some quartz veins, centimetric and late

(Photograph 5). The sector was sampled at three points, with chip-type samples. The first two samples were taken from representative outcrops with strong sericitic-argillic alteration and limonites; and the other sample was taken from the quartz veins. The results were the following: 1. There are no anomalous concentrations of gold and copper 2. There are low to moderate Fe concentrations (%) and they respond to the existence of limonites and hematites in the sampled areas. 3. The weak concentrations of S (%) show the low or no presence of sulfides.



Photograph 5. Profile of the quarry area in Sector Cecilia.

Based on the collected information, it can be indicated that the Cecilia Sector is a hydrothermal alteration zone related to brecciation events. Without any mineralization potential.

5. Geophysics

Geophysical studies were carried out by the Zonge Ingeniería y Geofísica Chile SA Company, with the main objective of evaluating the water potential of the Quilmenco Valley. The methodology used was Electromagnetic Transient (TEM), where the results allow to provide a detailed zoning of the resistivities that characterize the subsoil. Favorable resistivity conditions can be enhanced by the porosity and permeability of the rock, the presence of especially saline waters, clays and also sulphide mineralization. This last condition is important to consider and evaluate the results versus the detailed geology information. 8 profiles were made, one longitudinal and 7 transversal, with stations every 100 m. Which completes the execution of 8.6 linear km (Figure 5).

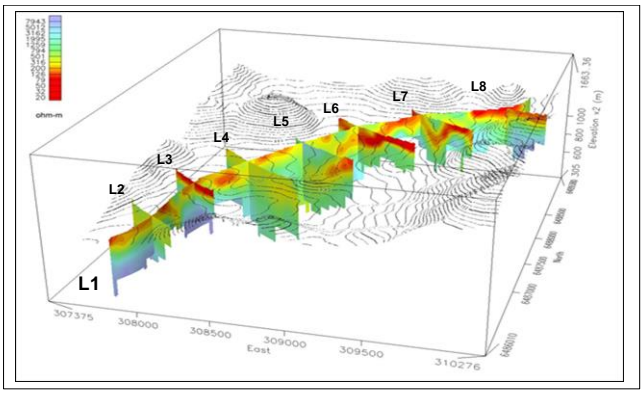


Figure 5. 3D visualization of resistivity sections modeled for the TEM study in the Quilmenco Valley. Viewed from the south-southeast.

The collected values vary between 12 and 20,000 Ωm, with an average value of 980 Ωm and a median of approximately 500 Ωm, considered the resistivity typical of the sector. In general, an increase in resistivity is observed at a greater depth. Results of line 1, drawn longitudinally in the axis of the current main stream, indicates the existence of a superficial layer of moderate resistivity (100-300 Ωm) with a variable thickness of between 50 and 150 m (Figure 5).

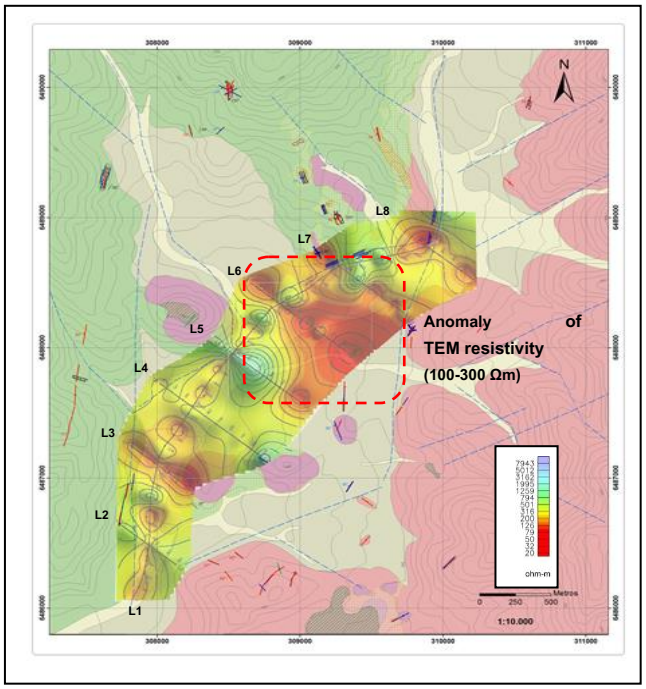


Figure 6. TEM resistivity plant located 50 m from depth. Comparison with Geology of the Quilmenco Valley 1: 10,000.

By contrasting the Geology of detail with the result of the TEM geophysics studies,

It is observed that the main low resistivity anomaly located on Line 6, which is related to an important area of discharge from secondary streams in the direction N20 ° -30 ° W towards the main stream of the Quilmenco Valley (Figure 6).

The position of these NW-SE streams and their discharge into the alluvial bed of Quebrada Quilmenco, are the main responsible for the presence of groundwater in these sediments and in permeable weathered rocks, which gives rise to shallow aquifers. This condition would explain the values of moderate-low resistivity, the sub-horizontal shape of the anomaly along the profile and their shallowness in the longitudinal axis of the valley.

However, it can also be observed that between sections 5, 6 and 7 there is penetration of the anomaly towards deeper levels (Figure 7).

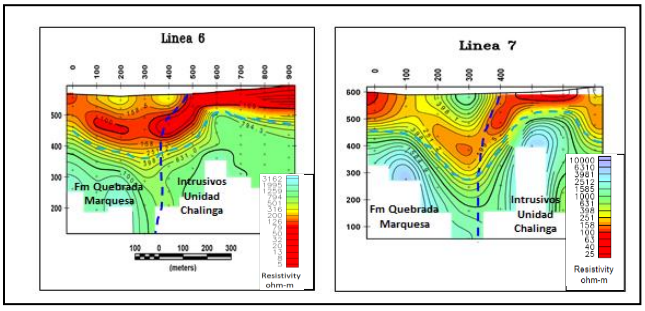


Figure 7: Geophysical profiles 6 and 7 (TEM). Blue segmented line: Interpreted limit of contact between intrusives and Quebrada Marquesa Formation.

The contact of a zone of high resistivity located to the east of the profiles is clearly recognized, with one of moderate resistivity that is deeper and subvertical. This condition is constant throughout the 3 indicated sections and could be related to the contact of the Chalinga Intrusive Unit and Minor Microdioritic Intrusives with volcanic rocks of the Quebrada Marquesa Formation and also the existence of deep N20 ° -30 ° W faults in this contact zone.

6. Soundings

Eight diamond drill holes were carried out with different objectives in the Quilmenco Valley sector. These total 355.60 m of drilling with a HQ diameter, 6 of them are vertical and 2 with a 55 ° angle of shake from the surface.

Two condemnation holes were made at the position of the future leaching plant. The others Drilling was carried out to assess the quality of foundation soils (4) where the recovery plant works (crushers, piles, etc.) and also hydrogeological drilling (2) would be installed.

The two damning diamond drill holes drilled are: PPM-QUIL-DH0003 and PPM-QUILDH0004) were mapped at a detail scale of 1: 100 and with the information obtained the geological section of the evaluated sector is constructed (Figure 8).

The information collected indicates the presence of andesites and breccia andesites, belonging to the Quebrada Marquesa Formation, cut by microdioritic intrusives that are part of the Minor Microdioritic Intrusive unit. Associated with this intrusion towards the west of the profile, irregular contact gaps are identified in the contact areas.

In the shallowest levels above the Redox Limit, located 25 m deep (Figure 8) there is an abundance of limonites, fractures filled with manganese oxides and moderate argilization, below this Redox Limit, the unit is strongly fractured and with the presence of pyrite disseminated in moderate proportions (1-2% vol., well PPM-QUIL-DH0003). The Microdioritic Intrusive that cuts the volcanic sequence has been recognized in both drillholes and is characterized by having a fine to medium equigranular texture. This texture is strongly obliterated in the leached zone.

In the contact zone, xenoliths of andesitic rocks and a contact gap zone with sub-rounded andesite clasts and mixing zones between the intrusive unit and the box rock are observed. Some major faults are identified, accompanied by minor parallel faults and moderate fracture zones. The mats of the mapped faults vary from 75 ° W to subvertical, but with the available information it is not possible to define whether it corresponds to faults with azimuth belonging to Domain NS or Domain N30 ° -50 ° W, since the surface of the sector is covered by unconsolidated sediments.

The alteration and mineralization recognized is very discrete, there is evidence of chlorite-epidote alteration in the background, with weak specularite and associated magnetite. In the contact gap zone, there is disseminated chalcopyrite at trace levels, associated with epidote. Locally and related to structural zones, there is sericitic alteration with an increase in disseminated pyrite (3% of the volume).

In this final stage of evaluation to condemn the study sector, it can be indicated, on the one hand, that the information recovered from the drilling with drillholes is consistent with the different geological aspects rescued in the field campaigns (lithology, structures, mineralization, etc.) and on the other, that the area does not constitute an area of interest with potential for significant copper and gold mineralization.

7. Conclusions and Recommendations.

All the specific programmed activities were carried out, which would allow to achieve the main objective of this study. The strategic areas for construction proposed by the Engineering in its Pre-Feasibility Stage and those of the immediate surroundings of the Quilmenco Valley, were studied in the field.

The detailed geological evaluation of these areas with possible mineralization potentials indicates the presence of 4 zones with evidence of mineralization (gold, gold-copper and copper), of which only the Esperanza Mine sector is of interest, as it has Attractive economic copper grades and for having mineralogical, occurrence and style similarities with mineralized zones of the Copper Stratified type (Papomono, Don Gabriel) nearby in the district. It is important to consider for this sector that possible exploratory works that could be carried out or possibilities of having a productive deposit, would not affect the execution of the works evaluated in this project. The location is 2 km to the NW of the strategic areas, it could even be considered as a profit opportunity,

As a conclusion of this phase of condemnation or discard, it can be indicated that the sectors where it is proposed to build do not have any important economic potential, which could imply a possible change of location or the re-evaluation of these sectors, therefore recommends occupying the land proposed for the construction of the necessary works for SC Minera Tres Valles.

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ANNEX N ° 1

Petrographic and Chalcographic Report

Prepared by Carmen Holmgren

June 2013

List of Samples Studied

Order No.	Sample	Transp.	Polished cut
1	QUIL 04	X	
two	QUIL-10	X	X
3	QUIL 12	X	X
4	QUIL-15	X	
5	QUIL 11-A		X

QUIL 04 sample

Macroscopic description

Fine phaneritic rock, where light gray crystals are observed and other fine black ones in interstices. The granulometry is quite homogeneous. There is magnetism, the reaction to the staining to detect potassium feldspar is very low and local.

Microscopic description

Rock with a subphytic texture with 75% tabular plagioclase crystals, with average sizes of 0.8 mm along the c axis. There are also some that reach larger sizes, such as 1.5 mm but they are exceptional. They present twins with diffuse planes due to various alteration processes, however, it is possible to define the composition that corresponds to labradorite. There is general turbidity due to the presence of clays of the montmorillonite type, superimposed appears fine sericite-illite. Prehnite formation occurs late, and epidote clusters sometimes overlap.

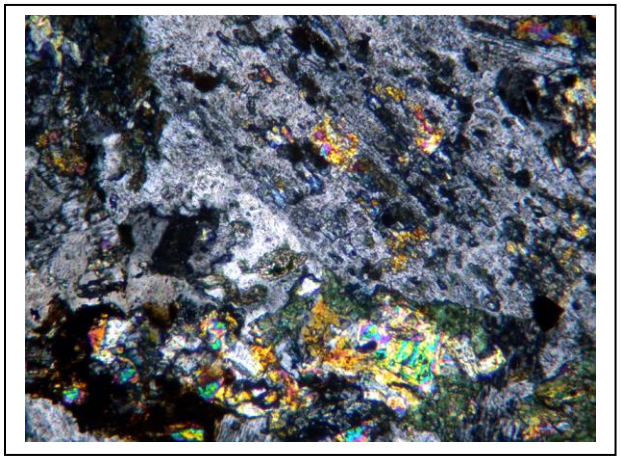
In interstices there are relics of ferromagnesians (20%), they are not well developed, they correspond to pyroxenes and some amphiboles, both with actinolitization, epidotization and chloritization. The presence of these secondary anhedral minerals is selective. The sizes are highly variable because they are interstitial, from 0.3 to 0.6 mm.

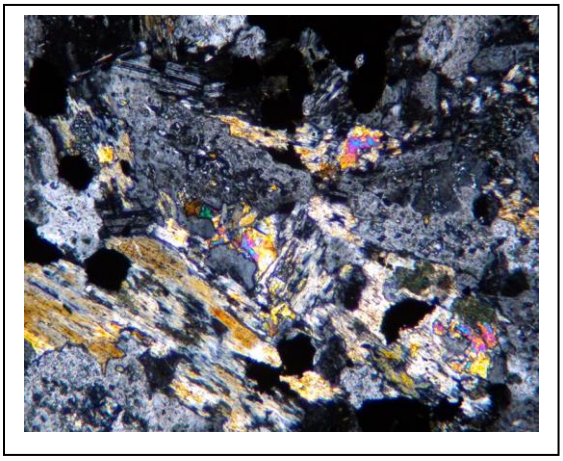
In interstices accompanying the ferromagnesian relics, opaque disseminations (5%) are observed in anhedral aggregates of various sizes, along with them also in these areas radial malachite aggregates appear.

The distribution of secondary potassium feldspar in the hand sample is irregular and in the section it is observed in a discontinuous sinuous vein, the mineral forms some medium-sized aggregates.

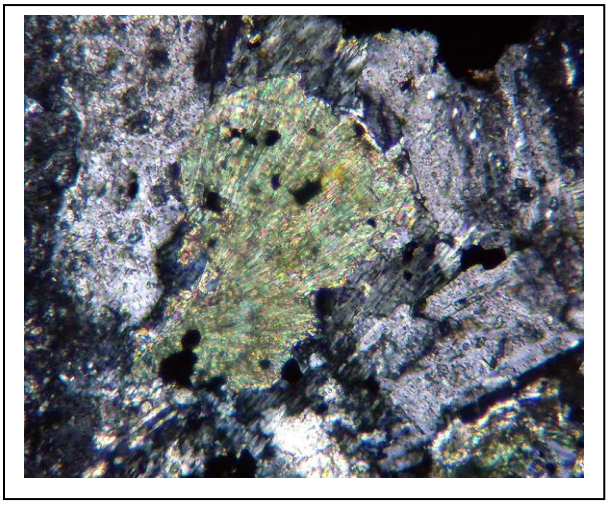
Rock Name: Altered Microdiorite.

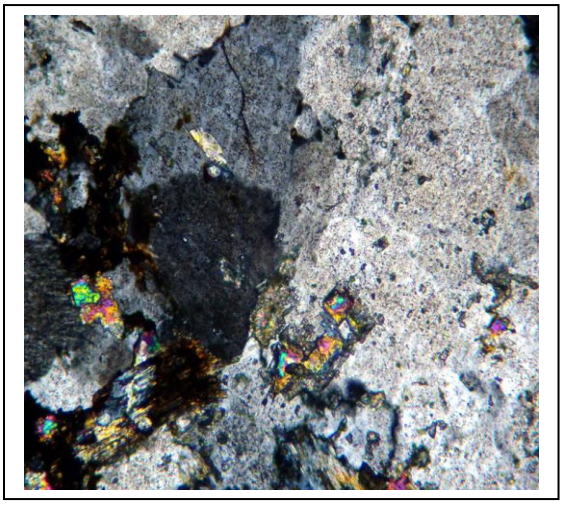
Sericita-illite	Epidote	Chlorite	Actinolite	Malachite	Prehnite	Clays	Feld.K
weak	weak	weak	weak	weak	weak	weak	weak





QUIL 04 sample. Left: Argilized plagioclase tablets, diffuse twins, in relic ferromagnesian interstices, with epidote, opaque and malachite. Right:
Plagioclase, in relic interstices of actinolytic amphibole, epidote and opaque disseminations. In both photos nicoles crossed, magnification by 40 times.





QUIL 04 sample. Left: Radial fibrous aggregate of malachite between chlorite; cloudy-looking plagioclase in its environment. Right: Potassium feldspar formation in a sinuous and truncated vein. Both with crossed nicoles photos, increased by 65 times.

QUIL 10 sample

Macroscopic description

Porphyry textured rock with white phenocrysts of short prismatic shapes and others elongated. The fundamental mass is microcrystalline with a somewhat greenish gray color. There are isolated dark brown and olive green clusters. No veinlets or fractures are observed. There is no reaction to staining to detect potassium feldspar and the rock is not magnetic.

Microscopic description

Rock with a porphyry texture, whose plagioclase phenocrysts reach 30% of the rock volume. The presence of ferromagnesians is very scarce and they appear as possible small relics of pyroxenes (5%). Plagioclase phenocrysts have well-developed tabular shapes, with sizes between 0.4 and 1 mm along the c-axis, giving the texture a somewhat serial appearance. The twins indicate that the composition is oligoclasaandesine, some reaching labradorite. They appear slightly cloudy due to the presence of clays. Altering plagioclase there are aggregates of epidote and in some fractures there is quartz.

Only short prismatic shadows replaced entirely by epidote can be deduced from the relict of ferromagnesian phenocrystals, and anomalous blue birefringence chlorite is preserved on some edges. There is no clear evidence for the presence of ferromagnesians.

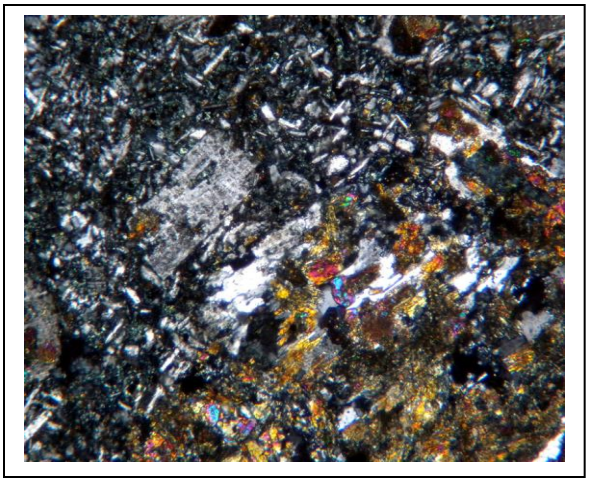
The fundamental mass has a fine intersertal texture, formed by plagioclase microliths; in the interstices there is abundant chlorite and fine opaque disseminations, among these there are also titanites.

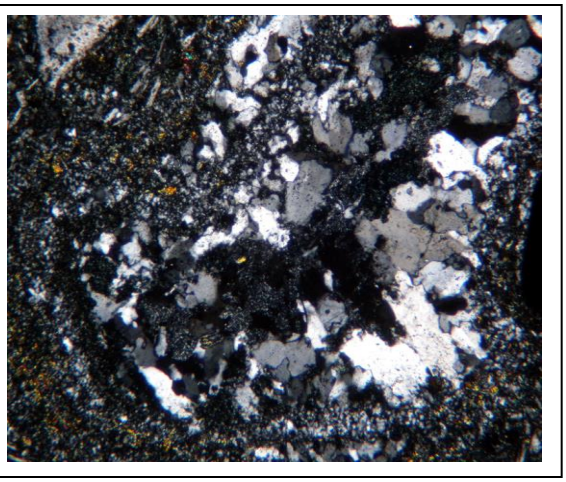
The rock also has the formation of tonsils, these have various shapes and sizes, they appear filled with aggregates of microcrystalline quartz and epidotes, sometimes chlorite aggregates.

In general there are areas of the fundamental mass that are being replaced by microcrystalline quartz.

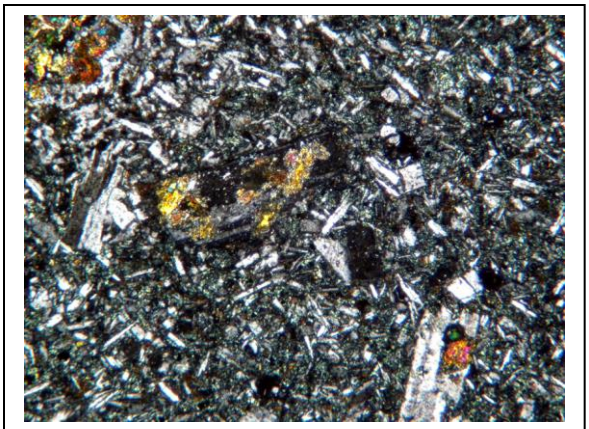
Rock Name: Andesite

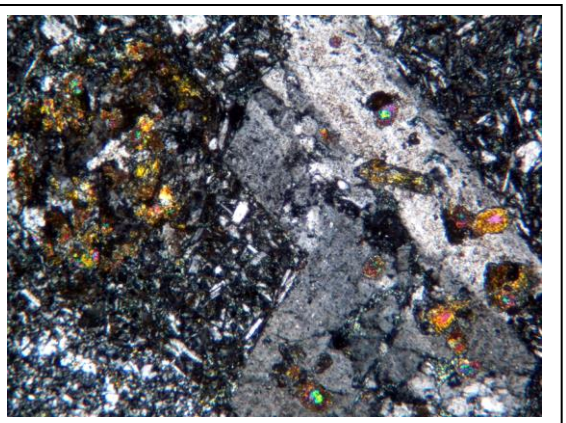
Epidote	Chlorite	Quartz
Moderate	**Weak**	**moderate**





QUIL 10 sample. Left: Plagioclase phenocrystal replaced by epidote, minor quartz, intersertal ground mass with interstitial chlorite. Right : Tonsil filled with quartz and central chlorite. Both photos with crossed nicoles, magnification by 40 times.





QUIL 10 sample. Left: Detail of the fundamental mass, intersertal texture with plagioclase microliths, interstitial chlorite, epidote clusters replacing a possible ferromagnesian phenocrystal. Right: similar, plagioclase phenocrystal, overlapping epidote clusters, side by side, epidotized ferromagnesian relict. In both photos nicoles crossed, magnification by 40 times.

QUIL sample 12

Macroscopic description

Rock with a porphyry texture, with abundant vesicles of different sizes and shapes. Tabular phenocrysts of white color are observed in a fundamental dark gray microcrystalline mass. There is no reaction to staining to detect potassium feldspar, nor is there magnetism.

Microscopic description

Porphyry textured rock with phenocrystals of plagioclase (20%) with variable sizes between 0.6 and 1.5 mm along the C axis. They occur in isolated individuals or forming glomerocrystals. They are twinned and the composition is labradorite. They present slight silting that gives them a cloudy appearance. There is fine sericite in some of them, but the most notable thing is the albitization of the crystals that manifests as ring-shaped “cleaning” in some crystals, it also penetrates through twin planes and fractures. There are no remnants of ferromagnesian phenocrystals.

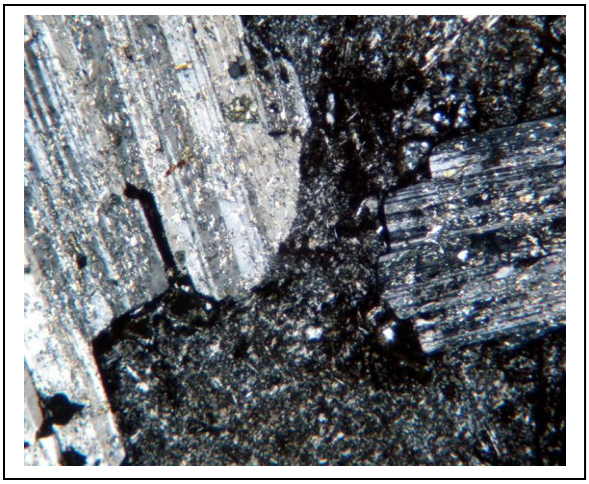
The fundamental mass is made up of small microliths of plagioclase. In interstices chlorite relics are conserved and there is abundant presence of cryptocrystalline quartz with hematite and limonites.

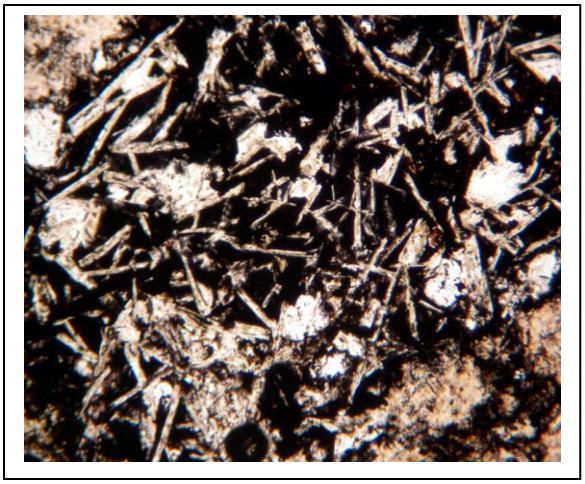
The rock presents a process of brecciation in a semi-plastic state, there are no straight planes and during this process a hematitized lava formed by larger microliths and oxidized glass penetrated the cavities or pores. This lava differs from the primary one and occupies only interstices between the fractures.

The fracture planes are sutured and marked by hematite.
The process described cannot be clearly observed in the hand samples.

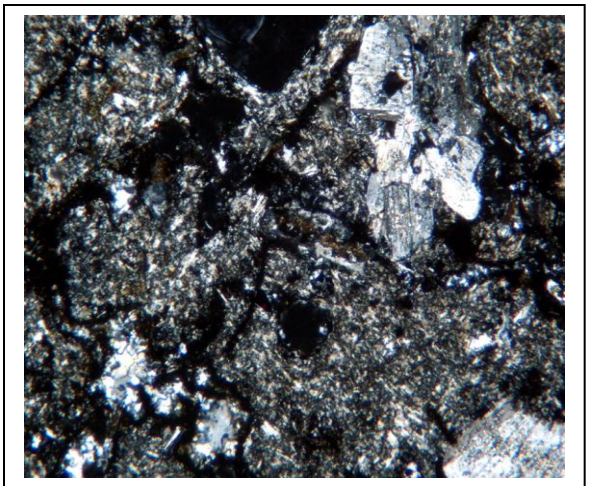
Rock Name: Self-overcrowded Andesite.

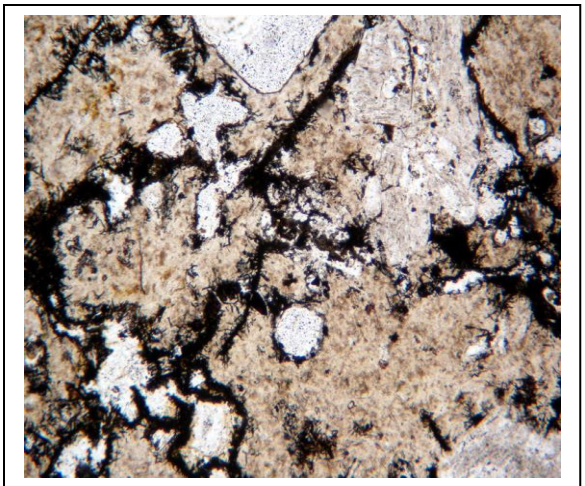
Sericita	Quartz	Albite	Hematite
Weak	Moderate	weak	moderate





M Our QUIL 12. Left: Argilized plagioclase phenocrystals with superimposed fine sericite, fine ground mass formed by microliths of plagioclase, chlorite, and interstitial quartz. Hematite in fracture planes. Crossed Nicoles, increased by 40 times. Right: Oxidized andesite formed by microliths of plagioclase in hematite interstices. This rock fills cavities and brecciation interstices. Nicole parallels. Increase by 40 times.





QUIL sample 12. Left: Detail of the ground ground mass, where there is disorder in the distribution of the microliths and aggregates of microcrystalline quartz in cavities. The fractures marked by hematite. Crossed Nicoles, increased by 40 times.
Right: similar to photo above with parallel nicoles.

QUIL 15 sample

Macroscopic description

Light colored, slightly pinkish rock, retains relics of porphyritic texture, there is no reaction to staining to detect potassium feldspar, there is no magnetism. Areas with more or less presence of hematite are observed, in the hand sample, these appear as brown bands interspersed with other lighter ones.

Microscopic description

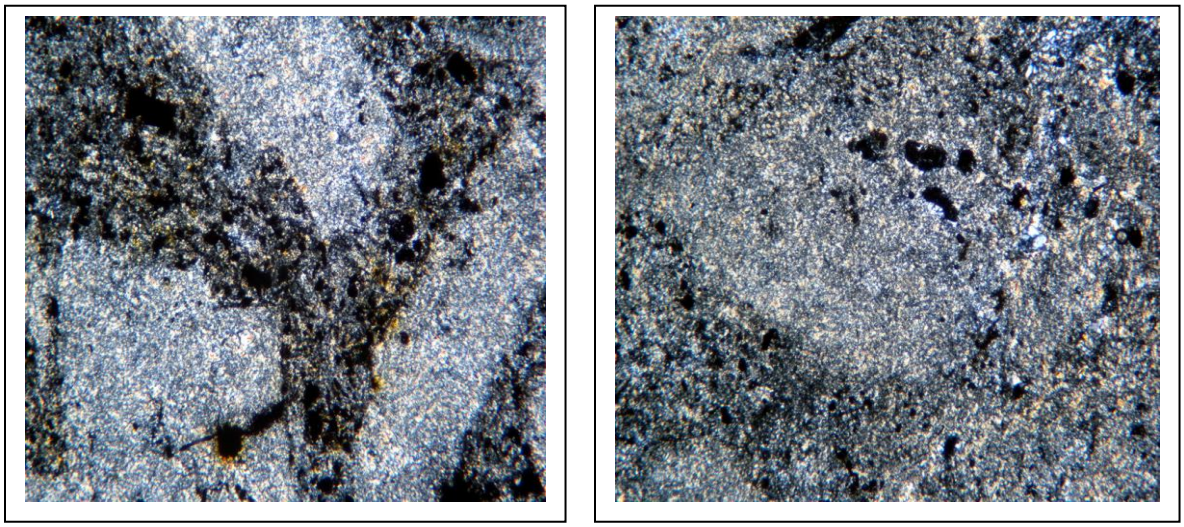
Porphyry textured rock with relict shadows of plagioclase phenocrystals, in individual crystals or glomerocrystals, these relics appear replaced by very fine sericite The contours are preserved but there are no remains of twin planes or zonation. Relics reach 35% of the volume of the rock. No ferromagnesian remains are observed.

The fundamental mass, like the phenocrystals, appears replaced by fine sericite, in areas chlorite relics are conserved, clusters of montmorillonite and in general there is a dissemination of opaque ones, especially hematite and some cryptocrystalline quartz.

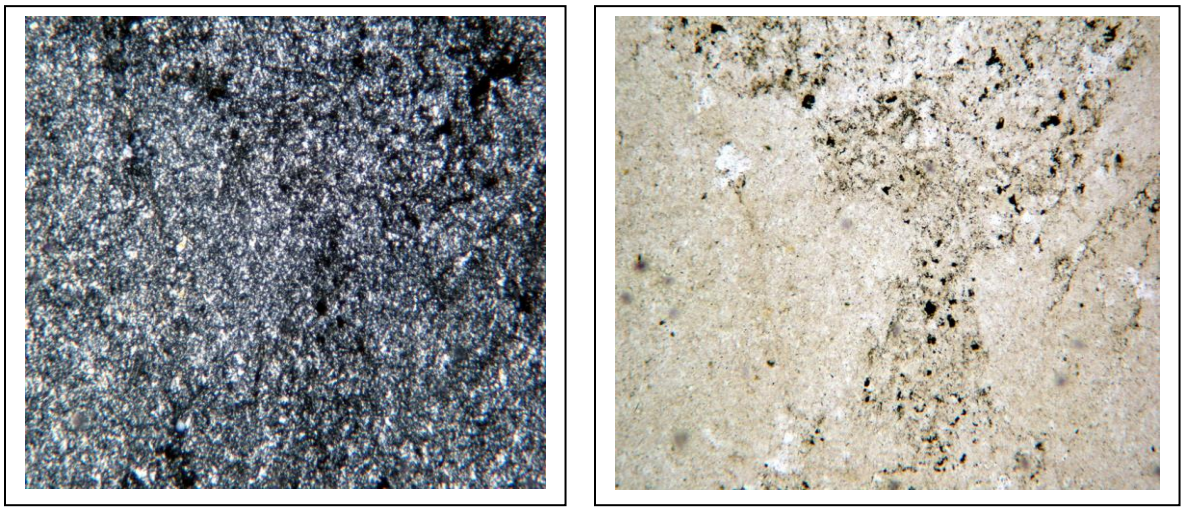
The distribution of hematite responds to the bands described in the hand sample, there are areas more enriched than others, there are guides with limonites. In the area with the greatest hematitisation, there is crystalline quartz filling cavities.

Rock Name: Altered Andesite.

Sericita	Hematite	Quartz
Strong	Moderate	Weak



QUIL 15 sample. Left: Relicts of sericitized plagioclase phenocrysts, altered fundamental mass, with fine sericite, interstitial chlorite, abundant opaque scattered, photo corresponds to band enriched with hematite. Right: Intermediate zone with greater sericitization and reduction of opaque. Both photos with crossed nicoles, magnification by 40 times.



QUIL 15 sample. Left : Detail of phenocrysts of plagioclase sericitized, the contours diffuse due to alteration, crossed nicoles, magnification 40 times. Right: the same photo with parallel nicoles, it is possible to differentiate the fundamental mass with sericite, some chlorite and opaque disseminations.

QUIL 10A

Polished cut

Texture

Spotted vein area with thick sulphide spots (1mm and more) between white quartz gangue and some limonites in guides.

Microscopic description

Pyrite-chalcopyrite vein zone whose main gangue is well crystallized milky quartz. Pyrite is the main mineral, generally euhedral, sometimes in a pyrohedral habit and with crystal sizes between 0.5 and 1 mm.

Chalcopyrite was deposited significantly surrounding it but now central pyrite relics remain, in cases meta-matized almost completely by chalcopyrite. The original chalcopyrite stains had diameters of up to 1 cm

Secondary chalcosine is digenite. It seems to be accompanied by a certain decrease in volume with respect to the replaced chalcopyrite, which is supplemented with limonites, giving it a spongy texture effect composed of chalcosine and limonites. This pair of minerals can form thick spots, without chalcopyrite relics, up to 5mm. There are also fine edges of limonites per pyrite in sectors without chalcosine.

The cut was run systematically in oil and at 500x magnification. No visible gold was found. Pyrite contains frequent chalcopyrite inclusions of no more than 0.5 um
Rare in chalcopyrite and in quartz "little worm" perhaps of electrum is seen but very doubtful.

Minerals present

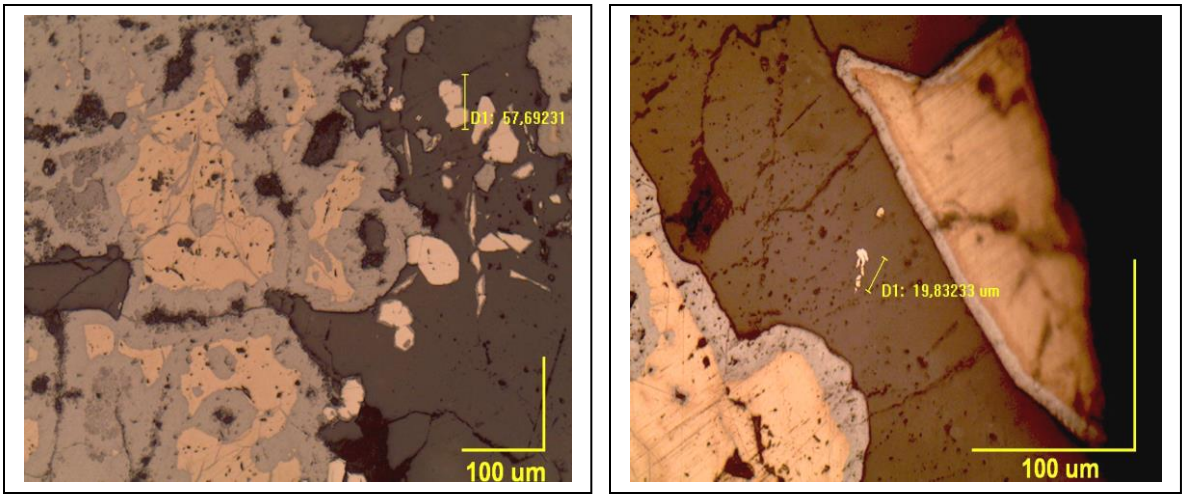
Mineral	% in Mineral Volume		% by Vol.
pyrite	25	limonites 1	
chalcopyrite 5			
chalcosine	10		

Succession for tentative genetics

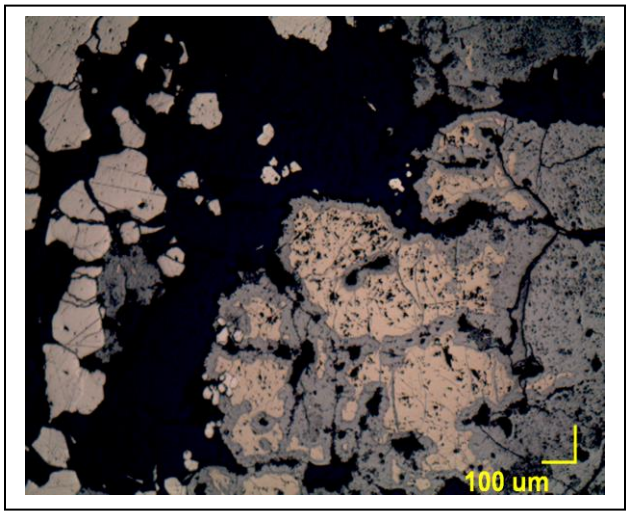
Pitite-chalcopyrite-chalcosine-limonite

Type of ore.

Very secondarily enriched chalcopyrite - pyrite quartz vein.



QUIL 10 sample. Left : Chalcopyrite with thick edges of chalcosine, some limonite (gray) On the right, well-preserved pyrite crystals on quartz. Increase by 100 times Right: at the center in quartz elongated deformed vermiform crystals (doubtful electrum) and, on the left
right, chalcopyrite, with a chalcosine border. Magnification by 200 times. N. parallels.



Sample QUIL 10 A On the left pyrite without major chalcopyrite and, on the right, a sector with abundant chalcopyrite always being replaced from edge to center of its grains by blue chalcosine. Increase by 40 times. N. parallels

QUIL 11 A

Polished cut

Quartz vein zone with strongly limonitized Fe and Cu sulphides and abundant green ox of well crystallized Cu radials green tone of brochantite and other light blue of minor chrysocolla.

Microscopic description

Quartz vein with good subhedral to euhedral quartz crystals that mark their growth zones accompany an ore basically formed by pyrite and chalcopyrite originally quite euhedral pyrite is in cubic and dodecahedral habit, with crystals mediate originally up to 3 mm. Pyrite was very pure, rarely with minor chalcopyrite inclusions. The ore is leaching and the pyrite is surrounded by broad concentric banded ridges of limonites, goethite and hydrogoethite.

Chalcopyrite was arranged in anhedral freckles almost always independent of pyrite and now it is also significantly transformed into chalcosine, some coveline and limonite as the outer border. Small anhedral freckles are preserved within quartz crystals that preserved it from the advance of oxidation

The entire cut is systematically checked for traces of gold but it was not found.

Minerals present

Mineral	Mineral Vol%		% by Vol.
Pyrite	3	Ox. Cu green 5	
Chalcopyrite 0.4		Chrysocolla type	0.5
chalcosine	0.1	Limonites group 10	
covelina	0.2		

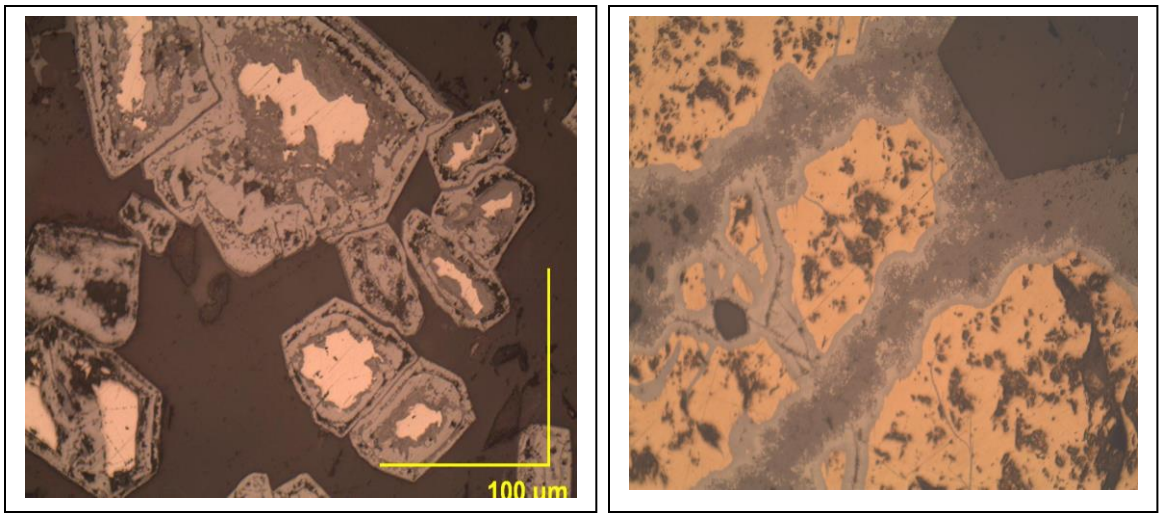
Green minerals sometimes in fine radial bundles suggest brochantite. There is some chrysocolla. doubtful of blue tone and in smaller quantity.

Tentative Paragenetic Succession

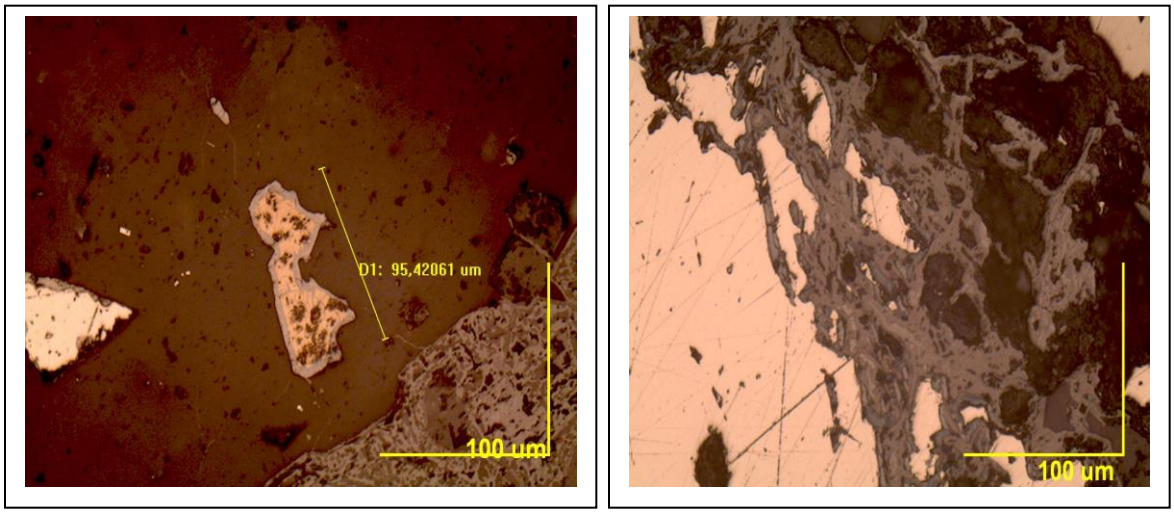
Pyrite-chalcopyrite / chalcosine-covelina // limonite group / chrysocolla brochantite

Type of ore

Pyrite-chalcopyrite veins in an advanced state of oxidation.



Sample QUIL 11 A. Left : Euhedral pyrite crystals with central relict of it surrounded by successive layers of the limonite group with different crystallinity. Magnification by 200 times. N. parallels. Right: exceptional major freckle of chalcopyrite preserved but with continuous edges of chalcosine, traces of covelina and frank limonites towards the outer edges. Magnification by 200 times. N. parallels.



Sample QUIL 11 A. I left : Granule preserved in quartz with chalcopyrite surrounded by a fine edge of chalcosine, below pyrite completely limonitized and already somewhat porous. Magnification by 200 times. N. parallels. Right: Limonitization progress in pyrite but leaving layers with little covelin and chalcosine between the goethite. Idem observation conditions. Magnification by 200 times.

Sample QUIL 12 A

Polished cut

Texture

Veined and interstitial.

Microscopic description

There are almost no primary metallic minerals.
It is a rather cataclysmic porphyry rock cut by veinlets of varying thickness with quartz and oxidized green Cu, apparently brochantite and chrysocolla with frequent fine specular hematite in clusters of disordered bundles. There are possibly other unrecognizable rusts and some jarosite.

Many times the former magnetites (0.3 mm dia.) Are now completely altered. Only the typical crystalline lattice between leucoxene is preserved and is preferentially replaced by this secondary suite of Cu oxides.

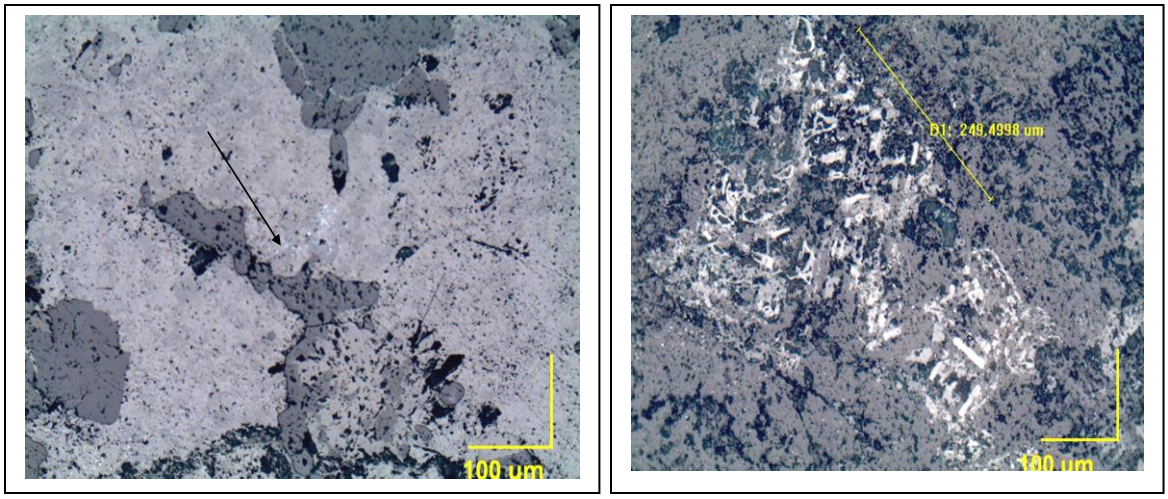
In larger veinlets there are within brochantite, malachite, few tiny fine crumbs of secondary covelin. (<0.01mm) Shows that there were sulfides and not all the oxidized mineral is indigenous to its current location. Perhaps only in the thinner veinlets (<1mm) the Cu oxides would be exotic with respect to their current precipitation location

Minerals present

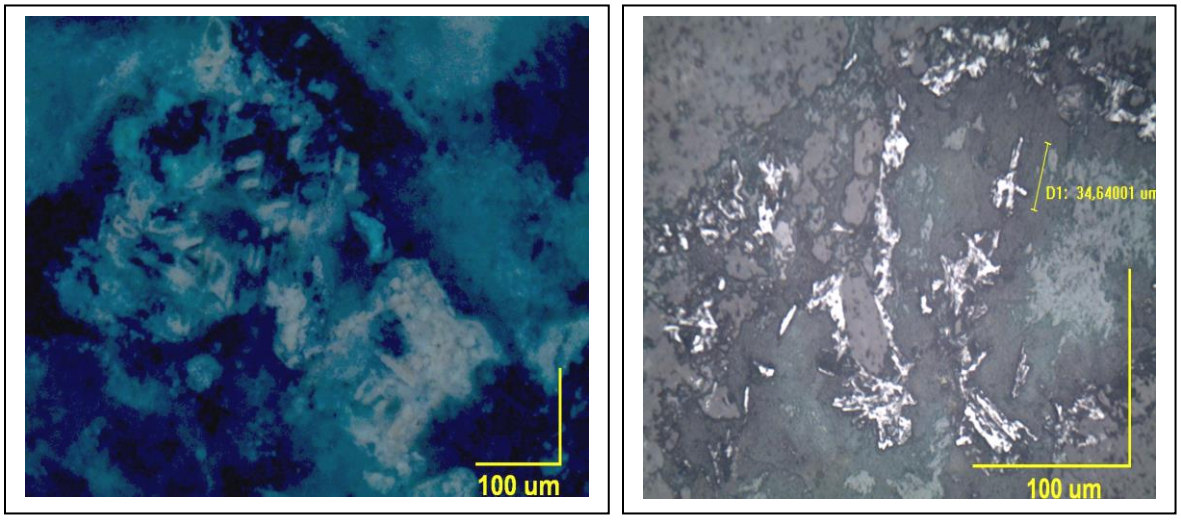
Mineral	% by Vol.
brochantite	5
chrysocolla and malachite 0.5	
Specularite secund. 3	
leucoxene	two

Type of ore

Remains of secondary enrichment but now Cu brochantite oxide and others prevail.



Sample QUIL 12 A. I left : Wide vein zone with brochantite and, in the center, preserved white points of covelite and secondary chalcosine. Magnification by 100 times. N. parallels. Right: ex magnetite from which remains its textural shadow marked by titanite and leucoxene, now invaded by green oxides and some quartz. 100 times magnification. N. parallels



Sample QUIL 12 A. I left : The same previous photo but with crossed nicoles showing the green reflections of brochantite between leucoxene and titanite In black secondary hematite

Right: specularite in fine rods, secondary between quartz and green oxides filling interstices in the box rock. Magnification by 200 times. N. parallels.