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Occurrence and Mineral Characteristics of Au-Ag-Cu-Bi Bearing Quartz Veins in the Estancia de la Virgen area, Guatemala

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ABSTRACT : This survey was carried out in order to delineate the occurrence of ore deposits and the mineralized characteristics in the Estancia de la Virgen area through the 1:2,000 scaled geological mapping and topographic measuring surveys. Gold-silver mineralization is in the fault block developed between the San Agustin Fault and Cabanas Fault. It is associated with ore bearing quartz veins controlled by the fault structure. The contents of Au and Ag range from traces up to 72 g/t and 180 g/t respectively. According to traversing the outcrops, the quartz veins are traced by 0. 5 Km trended to north and south. In those extended part, they continue for 1,000 m intermittently. Gold-silver mineralization could be divided into three stages. In the first stage, pyrite, galena, sphalerite, and chalcopyrite were formed with the primary silver and gold associated with galena and copper sulfides respectively. In the second stage, Cu-Bi-Au-Ag bearing sulfides such as chalcocite, covellite, and linarite are formed and usually deposited on the cataclastic fractures of galena and/or chalcopyrite. In the third stage, both the carbonation of galena and sphalerite and the sulphatization of galena took place in the surface environment. And then primary silver was carried away off and was deposited on galena and/or copper sulfides during oxidation near the water table. Low partitionings of Fe in sphalerite assist that the minerals were formed at the relatively low temperature, which is coincided with previously reported homogenization temperature of fluid inclusions.

INTRODUCTION

This study is a part of the Korea International Cooperation Agency (KOICA) Report entitled "The geochemical exploration project in the volcanic and metamorphic area in Motagua basin of Guatemala" which had been conducted by KIGAM (Korea Institute of Geology, Mining, and Materials) for three years from 1995 to 1997. The gold and silver ore deposit in this area was firstly found out by this KOICA project in 1996. Until recently, the geological and mineral explorations have not been performed in the area systematically.

The Estancia de la Virgen area is located in southeastern part of the San Agustin Acasaguastlan quadrangle which is bounded by 14°54'21" to 15°03'35"N in latitude and 89°47'23" to 90°00'00"E in longitude, and belongs to the El Progreso and Zacapa Provinces (Fig. 1). The climate of this area is high in temperature, and semi-arid. The annual rain fall is small, being suitable for the supergene enrichment of the primary sulfide ore deposits.

The lateral movement zone of San Agustin Fault contains more than five parallelled Au-Ag-Bi-Cu-bearing quartz veins which are distributed in the schist of Chuacus Series and trend to north-eastward with the widths of about 1.0 meter.

This paper is prepared in order to introduce the occurrences and mineralogical characteristics of the Au-

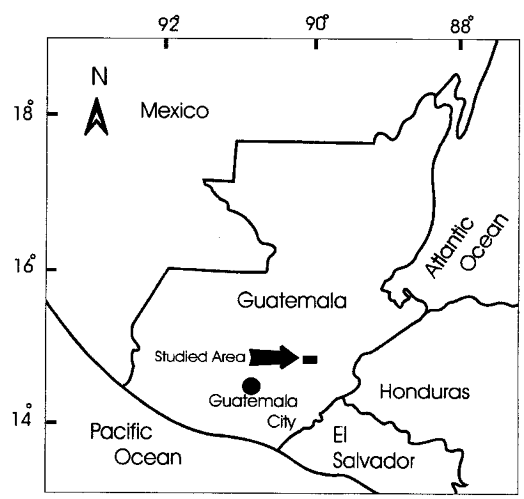

Fig. 1. The index map of the project area, Guatemala.

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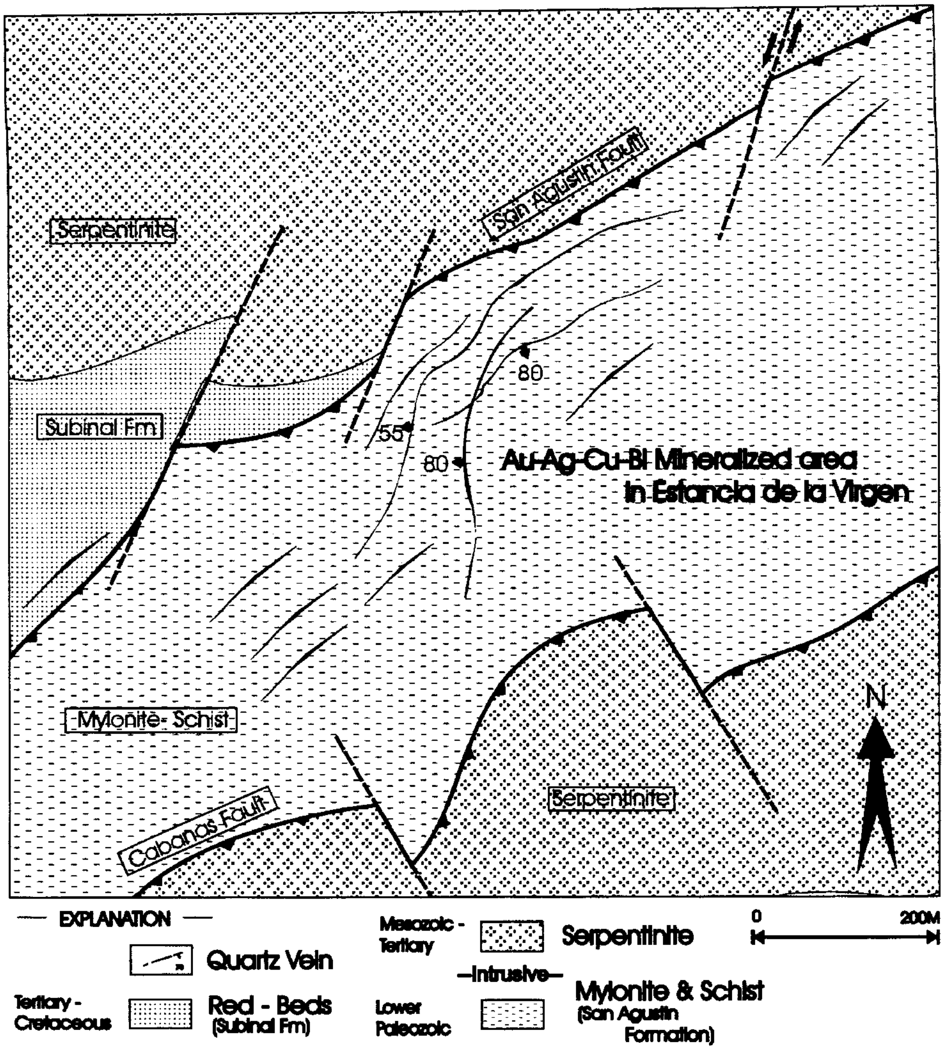

Fig. 2. The geology and tectonic block of Au-Ag-Cu-Bi mineralized area, Estancia de la Virgen area, Guatemala.

Ag-Cu-Bi-bearing quartz veins developed in tectonic blocks of the central Guatemala. In order to assess the ore grade, the quartz veins were analyzed by using fire assays, INAA, and ICP at KIGAM. The polarizing and reflecting microscope and scanning electron microscope were used for the mineral identification. The chemical compositions and textural characteristics of some ore minerals were also analyzed by the electron microprobe analyzer, JEOL JCMA 733 series and CAMECA SX 50.

GENERAL GEOLOGY

The geology of the study area is mainly composed of metamorphic and serpentinized rocks and small granite stock, which is classified to four units on the basis of the geology of the San Agustin Acasaguastlan quadrangle (Bosc, 1971); the serpentinite of Paleozoic to Mesozoic, the San Agustin Formation of Lower to Middle Paleozoic, the Subinal Formation of Tertiary to Cretaceous, and the granite of unknown age.

Serpentinites are distributed in the central and northern parts of the area (Fig. 2), and are classified into two types as follows; age-unknown serpentinites within shear zones, including exotic blocks and serpentinized peridotites (Bosc, 1971). Serpentinites in the area occur predominantly as the former type. Massive and sheared serpentinites cropping out as tabular shaped bodies are characteristically occur at the northern part and southern part of the San Agustin Formation with fault contacts. Sheared serpentinites contain a variety of tectonic inclusions consisting of amphibolite, schist, and limestone. Serpentinite in the northern part of the area has been affected strongly by hydrothermal alteration, resulting in the formation of two talc deposits and jadeite deposits.

The San Agustin Formation is distributed in the central part of the area (Fig. 2), and is mainly classified into four types: schists, migmatites, mylonites, and calcareous rocks with amphibolites. Schists are widely distributed in the area, and generally have the NE strike with a SE dip. They are mainly composed of quartz, feldspar, muscovite, and biotite. A distinct sequence of light gray-brown, fine to medium grained migmatitic rocks is exposed locally in this area. These rocks have a strong deformation by metamorphism occurring within a major fault zone and possibly having undergone more than one period of deformation. Mylonite is also found in some places. All contacts with the above rock types are caused by a low angle thrust fault with steeper dips to the north flattening to the south. The calcareous rocks are locally interbedded in the schist of San Agustin Formation.

The Subinal Formation is located in the northwestern parts of the study area (Fig. 2), and is mainly composed of gray, green, and red sandstone, channel conglomerates, and red silty shales and limestones. The Formation is classified into two rock types: red beds-rich and limestone-rich rocks. The red bed-rich rocks are distributed in the northeastern part of the area between the San Agustin Formation and Serpentinites by thrust fault and fault contacting, whereas the limestone-rich rocks occur as interbeds in the Formation, and were altered to epidote-clinopyroxene-chlorite facies.

Granite is distributed in the northern part of the survey area, and occurs near the boundary between the Sepentinite and the San Agustin Formation. A small granite stock intruded the Serpentinite in only one place of the area. The rock is fine- to medium-grained and consists mainly of quartz, plagioclase, biotite, K-feldspar, hornblende, and small amounts of sphene, zircon, and opaque minerals. Alteration minerals are epidote, sericite, and chlorite.

Fault has been a major role in structuring the San Agustin Acasaguastlan area, where Motagua fault is the dominant feature. This major discontinuity trends nearly EW across the area, separating metamorphic rocks to the north and south from rocks within the fault zone itself.

ORE DEPOSIT

Generally the mineralized quartz veins are distributed in the tectonic block of mylonitic schist of the San Agustin Formation which occurs between the San Agustin Fault in north and Cabanas Fault in south. The San Agustin Formation is dissected by a series of oblique fault along which mineralized quartz veins were filled accretionally.

The major quartz vein deposits with copper-lead-zinc-gold-silver mineralization appear to have been formed along fracture and shear zones, and commonly occur adjacent to major lithologic contacts by major faults, especially along the contacts between schist and serpentinite. Foliation planes which occasionally permit to embed the thin quartz veins parallel with the San Agustin Fault and dip predominantly to the north-west with medium angles.

In the Estancia de la Virgen area, there are five major veins. Principal No.1-1 and No.1-2 veins (Fig. 3) strike N45°~60°E and dip 50° to 80° NW or SE. Other veins are subparallel with a few splays off to the south-southwest. The relatively high grade ore veins, No.1-1 and No.1-2 veins, range from 0.6 to 3.0 m in width and extend over 500 meters. In the southern and northern extensions, they continue to 1,000 meter intermittently.

The outcrops of veins are generally milky white or milky gray in color, but are also cobalt blue locally in copper-rich part. The quartz vein has a lot of microstructures and the multi-stage thin quartz veins. The ore veins which are composed of chalcopyrite, galena, sphalerite, and pyrite are zoned in sequence from the chilled margin contacted by mylonitic schist to inner core zone with pure quartz. In zoned veins (e.g. samples no.77-1 to no.77-4), sphalerite is generally decreased in amounts from vein margins to center, whereas galena is increased toward the center.

As shown in Fig. 4, microscopic examination of ore minerals from outcrop of No.1-5 quartz vein indicates that supergene cemented process was formed during oxidation near the surface groundwater table. Fig. 4(C) shows the typical patterns of the cementation process of limonite during the oxidation of pyrite. Galena was replaced by anglesite, and was infiltrated by chalcocite and covellite along the cataclastic fractures (Fig. 4(A), (B), and (C)).

Even though Au, Ag, Cu, and Bi contents in quartz veins are spatially quite variable and uneven, economic concentrations of these metals are concentrated in the area accompanying the oxidation of sulfides, silicification, kaolinization, and talcfication developed in especially sheared zone. Silver contents in veins are generally proportional to the amounts of bismuth associated with galena and copper sulfides. Gold tends to occur as native gold or is associated with simple copper and copper-iron sulfides.

The maximum grades of gold and silver in the

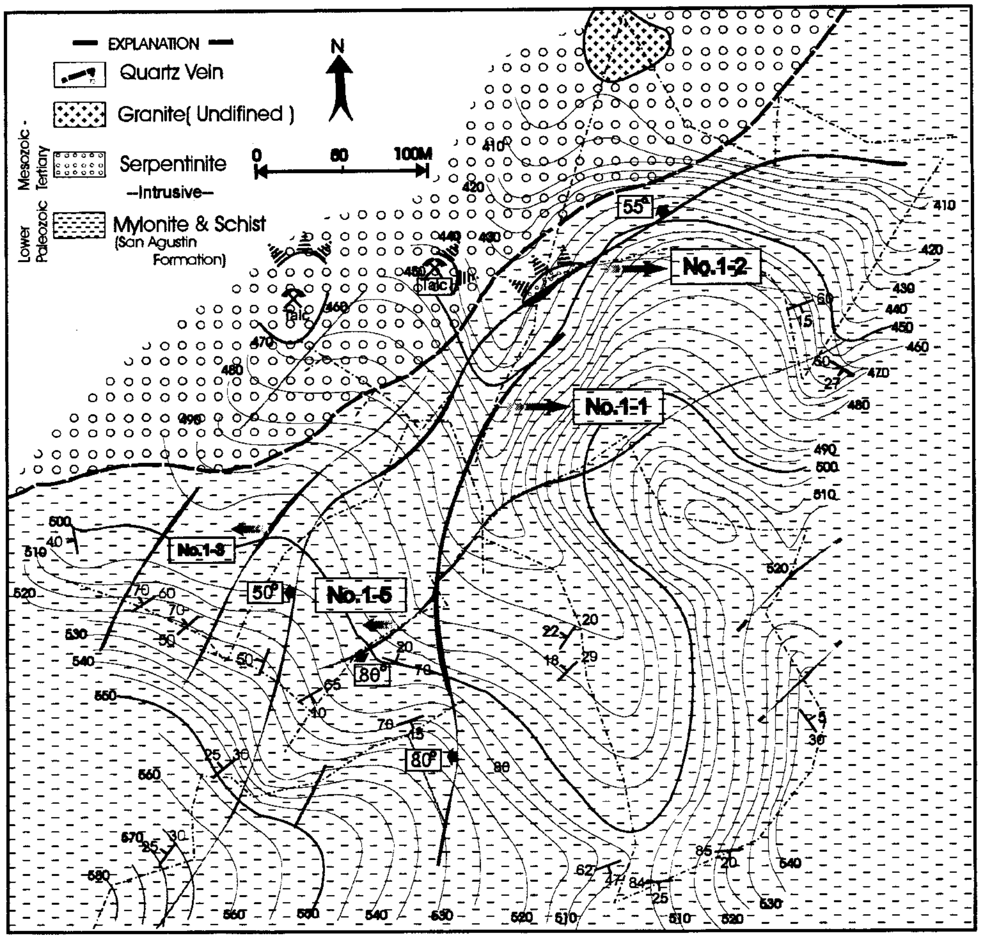

Fig. 3. The geologic map of Au-Ag, Cu, Bi mineralized area in the Estancia de la Virgen, Guatemala.

veins with supergene enrichments of copper sulfides such as chalcocite and covellite range up to 73 g/t Au and 180 g/t Ag. Locally the gold and silver grades of quartz veins seem to be proportional to the amounts of galena and chalcopyrite.

MINERAL CHEMISTRY

Based on microscopic observation and electron probe microanalysis, major ore minerals such as galena, sphalerite, pyrite, chalcopyrite, chalcocite, covellite, and linarite, and minor amounts of smithonite, anglesite, and cerussite were observed (Table 1). The chemistry of ore minerals will be described in this section.

Galena

Galena is one of the major ore minerals in this area. Most galenas contain minor amounts of silver (Table 1) ranging from 0.18 wt.% to 0.82 wt.% (average 0.7 wt%). Bismuth contents in galena range from 0.27 to 1.58 wt.% (average 1.2 wt%), and are proportional to the silver contents in galena. Copper impurities in galena range in amounts from 0.5 to 1.3 wt%. Galena from outcrops of No.1-5 quartz veins contains 2.05 wt% of Bi, 1.12 wt% of Ag, 0.02 wt% of Au, and 0.19 wt% of Cu in average contents.

Fig. 4(D) and Fig. 5(A) present the typical occrrences of silver bearing minerals generally associated with galena. Generally scattering of Ag X-ray image (Fig. 7) is distributed in galena evenly. Meanwhile in oxidation zone, highly concentrated Ag in galena is associated with chalcocite, covellite, and linarite.

Sphalerite

The major impurities of sphalerite are mainly Fe and Cu with small amount of Bi, Ag, and Mn. The spha-

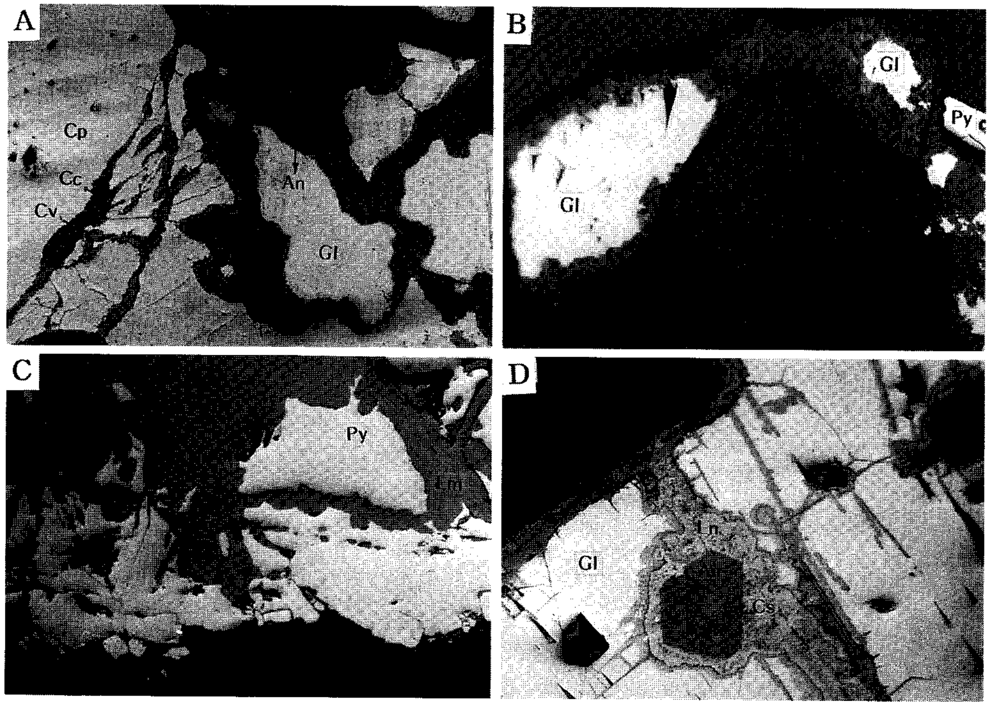

Fig. 4. Microphotographs of ore minerals in quartz vein from the Estancia de la Virgen area, Guatemala. (A) Galena (Gl) and sphalerite (Sp) islands in anglesite (An) deposited during oxidation process. Chalcocite (Cc) occurs in the fissures of chalcopyrite and shows the uniform rim of covellite along the marginal part (Sample from No.1-1 vein, SA96). (B) Linarite (Ln) is precipitated on galena which is replaced by anglesite (An). The galena and anglesite contain about 1% silver (Sample from No.1-1 vein, SA96). (C) Pyrite remnants in the zone of cementation (Sample from No.1-5 vein, SA134). (D) Linarite (Ln) and anglesite (An) are precipitated on the fissures of galena. Cerussite (Cs) remains in the inner part of anglesite (Sample from No.1-2 vein, SA105). Abbreviations: Py=Pyrite, Cp=Chalcopyrite, Sp=Sphalerite, Gl=Galena, Ak=Aikinite, Cv=Covellite, Cc=Chalcocite, Ln=Linarite, Sm=Smithonite, An=Anglesite, Cs=Cerrusite, Lm=Limonite, Au=Gold, Ag =Silver, Qz=Quartz.

lerite shows the compositions of $Zn_{(0.98\sim0.89)}Fe_{(0.11\sim0.02)}S$. As shown in Fig. 5(C) and (D), chalcopyrite blebs were exsolved with some orientations along cleavage cracks and/or cataclastic fractures.

As shown in Fig. 6, iron content in sphalerites is decreased from vein margins (early) to center (late). This may reflect general decrease of temperature with time. Meanwhile other impurities such as Zn, Bi, Cu, and Ag in sphalerite tend to increase in amounts toward the vein center. In supergene alteration zone, sphalerite is usually altered to smithonite (Fig. 5(B)).

Chalcopyrite

Chalcopyrite usually occurs as exsolution blebs in sphalerite. Chalcopyrite is uncommonly observed in bulk samples but in some fresh sample from outcrops. Most of chalcopyrites are anhedral, a part of which was permitted to be infiltrated and precipitated by copper sulfides on the cataclastic fracture or weak cleavage of minerals. The composition of chalcopyrite is considerably pure, $CuFeS_2$ as shown in Table 1. The atomic percent of ZnS in chalcopyrite ranges up to 0.56 wt%. The chalcopyrite samples taken from the zoned quartz vein show the general decrease of Fe content from vein margins to vein center, as shown in Fig. 6. The Au and Ag contents in chalcopyrite are up to 400 ppm and 300~900 ppm, respectively. The Ag content in chalcopyrites increases from vein margins to vein center, whereas the Au content decreases toward the vein center.

Pyrite

Pyrite is less common in the survey area, because most of hypogene pyrites were altered to limonite by the supergene alteration. Both limonite and pyrite contain 500 ppm of gold and 400 ppm of silver in average contents, which may be interpreted as me-

Table 1. The compositional ranges of ore minerals in the Estancia de la Virgen area, Guatemala. (unit : wt.%)

Composition	Cu	Fe	Zn	Pb	Bi
Chalcopyrite	33.84~35.04	29.24~31.47	0.00~0.78	0.00	0.00~0.03
Galena	0.01~1.25	0.00~0.03	0.00~0.05	80.76~87.01	0.27~2.05
Pyrite	0.00~0.08	47.54~48.53	0.00~0.95	0.00	0.00
Sphalerite	0.17~0.71	0.97~6.20	60.43~65.12	0.00	0.00~0.06
Covellite	63.20	0.00	0.00	0.00	0.00
Chalcocite	69.51~69.78	0.00	0.00	4.00~6.31	0.08~0.66
Linarite	41.49~59.51	0.01~0.49	0.00	11.25~25.70	0.00~0.85
Smithonite	0.00	0.98	44.06	0.01	0.08
Anglesite	0.15~9.94	0.00~0.07	0.00~0.05	54.48~65.76	0.00~6.44
Cerrusite	0.14~7.95	0.04~0.19	0.00~0.01	55.50~77.59	0.00~2.06
Limonite	0.00~5.05	44.62~57.61	0.00~3.91	0.00~4.64	0.00~0.47

Table 1. Continued.

Composition	Mn	Sb	Au	Ag	S
Chalcopyrite	0.00~0.01	0.00	0.00~0.03	0.00~0.09	32.68~35.18
Galena	0.00~0.06	0.00	0.00~0.02	0.16~1.11	13.90~15.20
Pyrite	0.00~0.03	0.00	0.00~0.06	0.00~0.02	50.37~53.61
Sphalerite	0.00~0.03	0.00	0.00	0.00~0.02	33.24~33.94
Covellite	0.00	0.03	0.03	0.00	35.56
Chalcocite	0.00~0.66	0.00~0.02	0.00	0.24~1.69	20.29~21.36
Linarite	0.00	0.00	0.00	3.71~5.04	14.34~17.63
Smithonite	0.00	0.02	0.00	0.00	0.02
Anglesite	0.00~0.07	0.00	0.00~0.06	0.00~1.74	6.41~9.06
Cerrusite	0.01~0.09	0.00	0.00	0.00~0.01	0.00~9.04
Limonite	0.00~0.06	0.00~0.02	0.00~0.08	0.00~0.01	0.01~1.80

chanical admixtures (Table 1). Pyrites from No.1-5 quartz vein contains Au and Ag up to about 0.06 wt% and 0.01 wt%, respectively (Table 1).

Chalcocite and covellite

Chalcocite contains impurities such as Pb, Bi, Au, Ag, and Sb ranging from traces to very large amounts. Chalcocite contains 0.19 wt% of Ag and 0.89 wt% of Bi in average contents. Also Au and Sb are contained by 0.01 wt% each in average amounts. In sample SA 86, chalcocites contain 3.18 wt% of Pb, 2.08 wt% of Bi, 0.13 wt% of Au, and 3.47 wt% of Ag.

Covellite contains about 0.03 wt% of Au and Sb each in average contents. Silver might have been remobilized by the dissolution of chalcocite or covellite in supergene cementation zone, and deposited on cataclastic fracture, weak cleavages and grain boundaries of especially galena.

Other ore minerals

Table 1 shows the average elemental compositions of anglesite (PbSO4), linarite ($2[PbCu(SO_4)(OH)_2]$), smithonite ($ZnCO_3$), and cerrusite ($PbCO_3$) from the outcrop of No.1-1 vein. Silver contents in chalcocite and covellite range up to 4.8 wt.%. Gold has a tendency to be developed in simple iron sulfides in early stage and could be observed in bulk ore sample as native gold occasionally.

Linarite is a widespread secondary mineral in the oxidized zone of lead-copper-silver deposits. This mineral has small amounts of impurities such as antimony (0.02 wt%). The linarite containing 4.2 wt% of silver and 0.4 wt% of bismuth was precipitated along the fractured cleavages of galena (Fig. 4(D) and Fig. 8).

The carbonates of lead and zinc, such as cerussite and smithonite, occur along the cleavages and fractures of galena and sphalerite as alteration products in near-surface oxidized zone. Especially cerussite contains 2.10 wt% of copper and 0.21 wt% of bismuth in average contents.

Anglesite is developed in the margins, cleavages and/or fractures of galena. It contains about 3.61 wt% of bismuth, 1.39 wt% of silver, and 6.81 wt% of copper. This is a typical pattern of oxidation of copper sulfides precipitated on the cleavage plane or fractures of galena

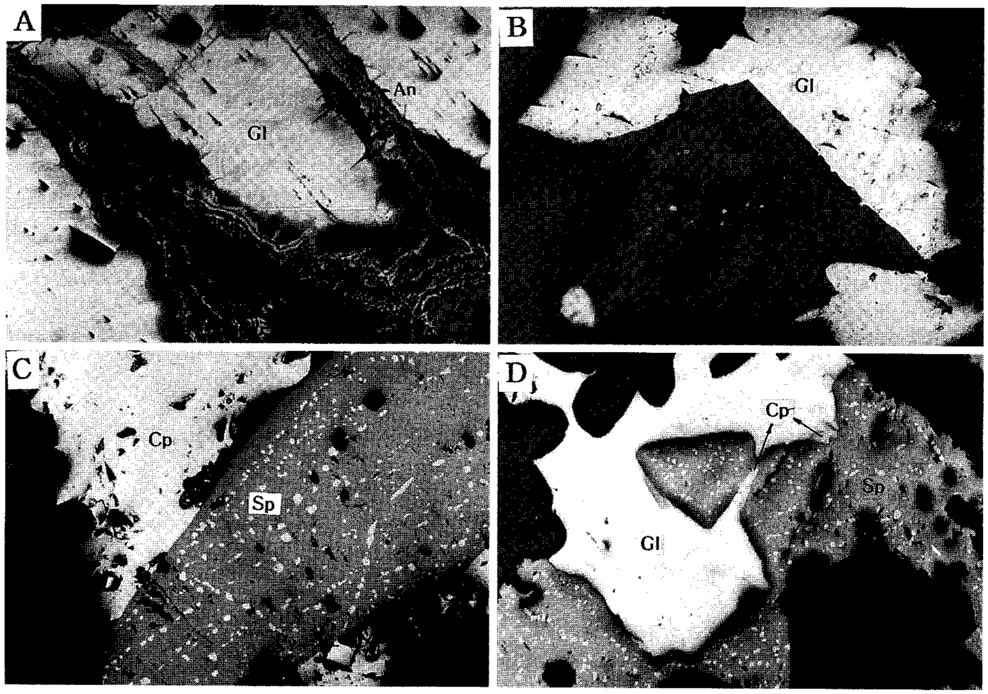

Fig. 5. Microphotographs of ore minerals in quartz vein from the Estancia de la Virgen area, Guatemala. (A) Galena is replaced by anglesite (An) during oxidized cementation. Limonite occurs as rhythmic thin crust (Sample from No.1-2 vein, SA105). (B) Sphalerite is replaced by smithonite (Sm) in oxidized zone (Sample from No. 1-1 vein, SA77-2). (C) Sphalerite (Sp) and chalcopyrite (Cp) are interlocking each other. Chalcopyrite exsolution in sphalerite (Sample from No.1-1 vein, SA77-2). (D) Chalcopyrite exsolution in sphalerite and marginal blebs of chalcopyrite, sphalerite is necked by galena growth (Sample from No. 1-1, SA77-4).

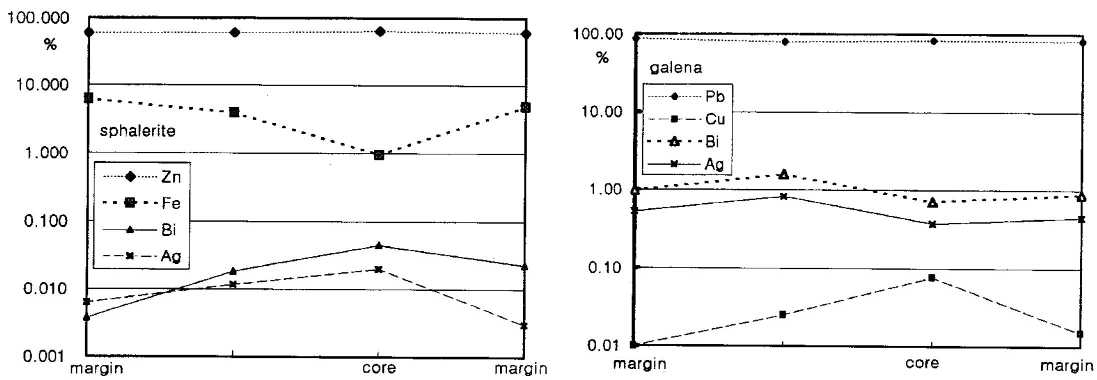

Fig. 6. The compositional variations of sphalerite and galena from zoned quartz vein (sample SA77-1 of No.1-1 quartz vein) in the Estancia de la Virgen area, Guatemala.

during supergene oxidation.

PARAGENESIS

Major ore minerals in veins of the survey area consist of galena, chalcopyrite, sphalerite, pyrite, and minor amounts of covellite and chalcocite. Anglesite ($PbSO_4$), smithonite ($ZnCO_3$), linarite ($2[PbCu(SO_4)(OH)_2]$), and cerussite ($PbCO_3$) are also observed in the oxidation zone.

Most galenas permitted the precipitation of copper sulfates or copper sulfides and in some part the rem-

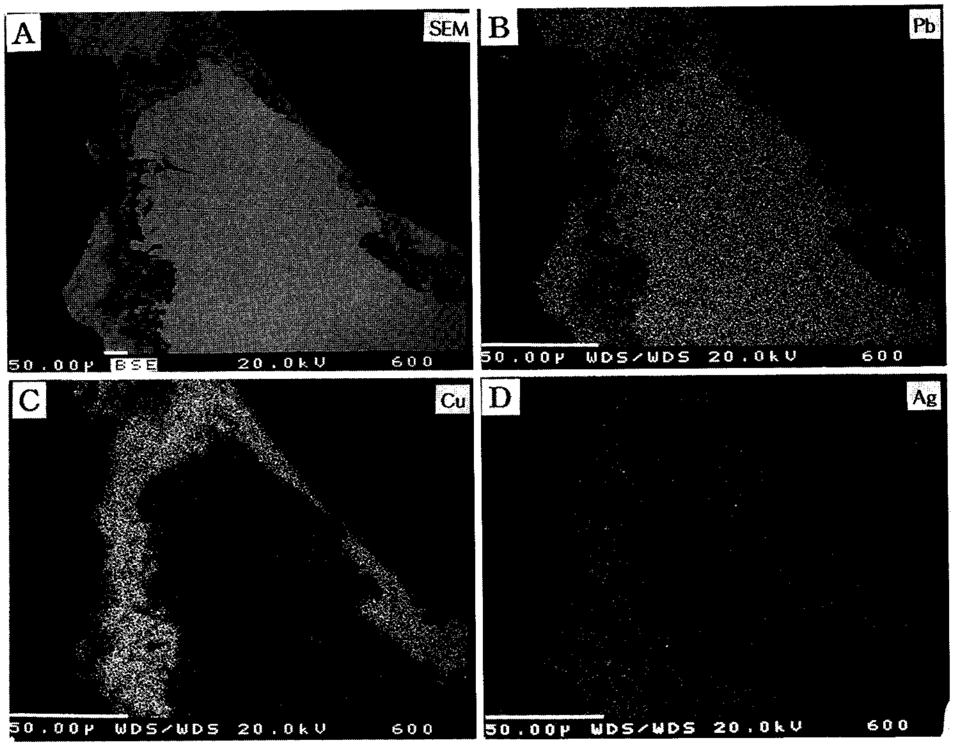

Fig. 7. SEM and X-ray images of Pb, Cu, and Ag for galena and covellite from the Estancia de la Virgen area, Guatemala (Sample SA96). (A) SEM image of galena on which covellite is precipitated in margin. (B) Linarite is deposited on galena, and in some part anglesite replaced the galena. (C) Linarite is precipitated along the marginal part of galena during the oxidation process. (D) Silver is concentrated in marginal part of linarite deposited on galena.

nants of cerussite and/or smithonite along the fractures. As shown in Fig. 4(D), some of galena was altered to cerussite in the marginal part and to anglesite in the inner part. Average content of silver in the cerussite is 0.4 wt%, which is smaller than that (1.0 wt% of silver) in anglesite at inner part, reflecting the leaching out of silver in margin part of galena.

The inner margin of galena was replaced by silver-bearing linarite, whereas the outer margin was replaced by silver-poor anglesite. The distribution pattern of bismuth and silver are duplicated with both elements. This phenomena may reflect that silver is associated with bismuth and enriched during the late supergene oxidation process.

The paragensis of Cu-Pb-Zn-Au-Ag mineralization in this area is divided into three stages in aspects of mineralogical association (Table 2). The mineral assemblage deposited in the first stage consists of pyrite, galena, sphalerite, and chalcopyrite with gold and covellite. In the second stage, pyrite, sphalerite, and galena with silver appear to have formed. In the third stage, supergene alteration was taken place in the surface oxidation zone, and formed the carbonation of sphalerite, the carbonation and sulphatization of galena, and the formation of covellite and chalcocite.

Gold mineralization is interpreted to be largely associated with pyrite, chalcopyrite, and native gold in the first stage, and also formed in the second stage as supergene gold which was deposited in sulfides in surficial environment. Silver mineralization is associated with galena in the first stage and with copper sulfides such as covellite and chalcocite in the second stage.

CONCLUSION

In the Estancia de la Virgen area, gold-silver mineralization occurs in the fault block developed between the San Agustin Fault and the Cabanas Fault, and is associated with quartz veins controlled by the fault structure.

Ore-bearing quartz veins generally trend toward 45°NE and dip 50°~80°NW, and are composed of parallel five lodes with each thickness of 0.5~3.0 meters. In the mineralized quartz veins, the ore minerals are mainly composed of galena, sphalerite, chalcopyrite,

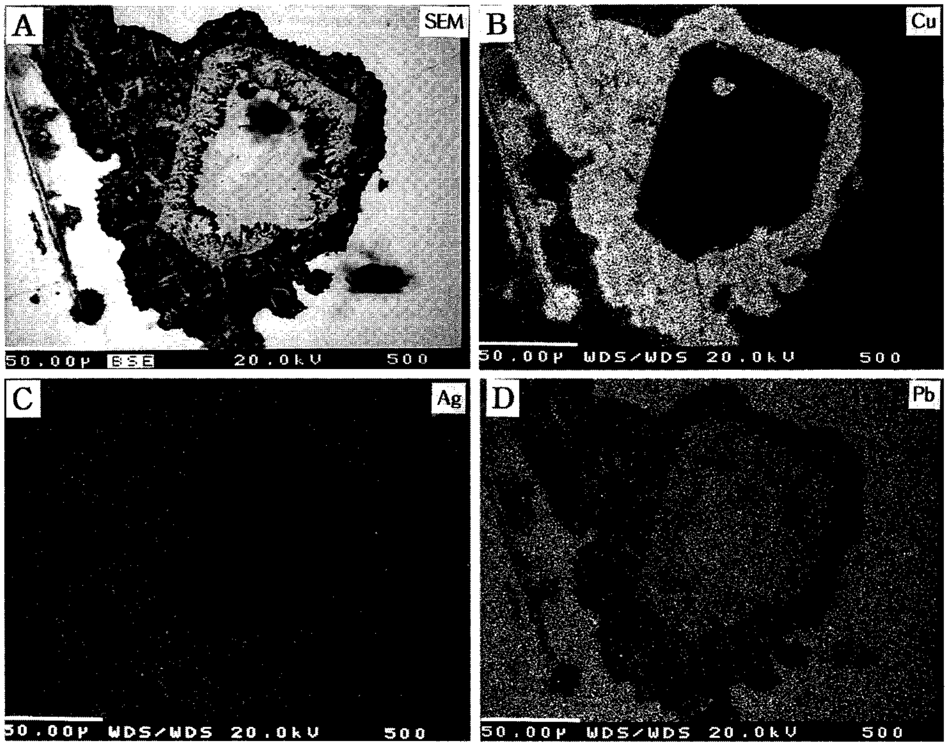

Fig. 8. SEM and X-ray images of Cu, Ag, and Pb of Pb-Cu-bearing sulfides and sulfates from the Estancia de la Virgen area, Guatemala (Sample SA105). (A) SEM image of galena and Pb-Cu sulfates such as linarite, anglesite, and cerussite. (B) Linarite deposited on galena. (C) X-ray image showing the concentration of Ag in linarite surrounding anglesite. (D) X-ray image of galena (outer part) and linarite (dark ring). Anglesite and cerussite occur as islands in center.

Table 2. Paragenetic sequences of ore minerals in the Estancia de la Virgen area, Guatemala.

STAGE	Stage 1	Stage 2	Stage 3
Pyrite	——— ······	——— ····	
Chalcopyrite	······———	——···	
Sphalerite	··———	——···	
Galena	··————	— ——····	
Covellite	········	·········	——···
Chalcocite		···········	——···
Linarite		·····———	——···
Smithonite		········	——··
Anglesite		·····	——···
Cerussite		········	——···
Limonite			··— —···
Gold	———·····	·——···	
Silver	··· ——— ···	——— ······	······
Quartz	······——— ·····	——···——	···········
Mineralization	Pb-Zn-Cu-Bi-Au	Cu-Au-Ag	supergene enrichment
Typical minerals	Sp-Cp-Gn-Py	Gl-Cp-Cv-Cc	Li-Q
Temperature		300°C~200°C	

Abbreviations: Sp=Sphalerite, Gn=Galena, Cp=Chalcopyrite, Py=Pyrite, Cv=Covellite, Cc=Chalocite, Li=Linarite, Q=Quartz.

pyrite, chalcocite, and covellite with secondary minerals such as linarite, smithonite, cerrusite, anglesite, and limonite. The grade of gold ranges from trace up to 72 g/t and that of silver is trace up to 180 g/t. Gold is developed in pyrite containing up to 0.06 wt.% Au, and in anglesite and limonite containing up to 0.08 wt.%, or as native gold. And silver is enriched in chalcocite and covellite up to 1.7 wt.%, galena up to 1.1 wt.%, in linarite up to 5.0 wt.%, and in anglesite up to 1.7 wt.%.

In terms of the paragenetic sequence of mineralization in this area, mineralization could be divided into three stages as follows. In the first stage, pyrite, galena, sphalerite, and chalcopyrite were deposited with the primary silver and gold mineralization associated with galena and copper sulfides, respectively. In the second stage, Cu-Bi-Au-Ag sulfides such as chalcocite, covellite, and linarite were formed along the cataclastic fractures of galena and/or chalcopyrite. In the third stage, the carbonation of galena and sphalerite, and the sulphatization of galena took place in the surficial oxidation environment. And then primary silver was carried away off and was deposited on galena or/and copper sulfides during the oxidation near the groundwater table.

Low partitioning of Fe in sphalerite suggest that the mineral was formed at the relatively low temperature, which is coincided with previously reported homogenization temperatures of fluid inclusions (Kim *et al.*, 1998).

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과테말라 Estancia de la Virgen 지역 금-은-동-비스무스 광화대의 산상과 광물특성

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이 연구는 과테말라 에스탄시아 데 라 비르겐 (Estancia de la Virgen) 지역에 분포하는 광화대의 산상과 광물특성을 밝혀내기 위해 수행되었다. 이 연구를 위해 1:2,000 축척의 정밀광상 지질조사가 이루어졌다. 금-은 광화작용은 산 아구스틴 (San Agustin) 단층과 카바나스 (Cabanas) 단층사이의 단층 블럭내에 발달하며 단층구조에 의한 규제를 받았다. 금은 미량에서 부터 최고 72 g/t, 은은 미량에서 최고 180 g/t까지의 품위를 보인다. 정밀광상 지질조사에 의하면 석영맥은 북동방향으로 연장 500 m 이상 추적되며 연속성은 불량하지만 1,000 m 이상 연장되는 양상을 보인다. 석영맥에서의 광물생성순서는 3개 단계를 나눌 수 있다. 1단계에는 황철석, 방연석, 섬아연석, 황동석이 일차 금-은 광물과 수반되며 2단계에는 휘동석, 코벨라이트, 리나라이트와 같은 Cu-Bi-Au-Ag 황화광물이 형성되었으며 이들은 대체로 방연석이나 황동석의 미세구조에 침착-부화되었다. 3단계에는 방연석, 섬아연석의 탄산염화작용, 방연석의 표성부화작용이 지표환경에서 일어났다. 이 과정에서 용탈된 일부 은이 지하수면 근처에서 산화작용이 일어나는 동안 동광석이나 방연석에 침착되었다. 섬아연석과 황동석에서 각기 Fe와 Zn의 함량이 적은 것은 이들 광물들이 비교적 저온에서 형성되었음을 의미하며 이는 이전에 연구된 유체포유물의 균일화온도와도 일치한다.