PART Ⅲ CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 1 CONCLUSIONS

1-1 Gelology and ore deposit

The geological formation of this area mainly consists of basement complex (pCCcb and pCCanf), greenstone (pCCps, pCCsj, pCCag and pCCsjo), ancient granite intrusive rocks (pCCG) and younger granite intrusive rocks (pCC) (Fig. II-3-2, Plate II-3-1～Plate II-3-4).

The basement complex is mainly composed of gneiss, schists, migmatite and amphibolite. The granite intrusive rocks of both pCCG and pCC, are composed of granite, granodiorite, leucogranodiorite and diorite. The latter is rather heterogeneous. Each of them partially comes under mylonitization and the foliation is recognized. According to the result of age determination, pCC shows the age around 1.7 to 2.0Gy, except Mal Abrigo (1.2Gy). This is consistent with the description in the existing information that the pCC is related in the Transamazonian orogenesis. On the other hand, wall rock (diorite to granodiorite) of the Mahoma mine, as a representative of pCCG, shows the age of 2.0Gy and a rejuvenation is presumed alongside that of the age before 2.2Gy found in existing information. It can be considered that the rejuvenation is caused by a mineralized alteration.

As for greenstone, the main part of the San Jose area, which is the principal part of the survey area, is composed of the central to eastern part of the Paso Severino formation (pCCps) and the western to southern part of the San Jose formation (pCCsjo). The former was subjected to a weak metamorphism, while the latter to a relatively high-grade metamorphism. The Cerros de San Juan formation (pCCsj) in the western part of the San Jose area was subjected to a weak metamorphism. The Arroyo Grande formation (pCCag) in the Arroyo Grande area to the north, was subjected to a weak to moderate metamorphism.

The greenstone is mainly composed of greenschist, basic to acidic volcanic rocks (metabasalt to metarhyolite), amphibolite, quartz schist, quartzite, metasandstone and slate to phyllite.. Adding to this, the San Jose and the Arroyo Grande formations are slightly intercalated with thin gneiss beds and the Cerros de San Juan formation with limestone and dolomite beds.

As a result of the field survey, the following 13 mineral showings were found as a zone where the quartz vein had been developed (Fig. II-3-7). Descriptions about each mineral showing are resumed in Tab. I-5-1.

The main part of the San Jose area (10 mineral showings)

A: surrounding area of the Mahoma mine (20km EW×15km NS)

B: Nueva Helvecia (the western extremity of the area : 10km×18km)

C: Arroyo del Medio (6km×15km)

D: Canada de Cabrera (8km×4km)

E: Arroyo charruzo (10km×12km)

F: Tala I (3km×4km)

G: Tla II (9km×14km)

H: West of 25 de Mayo (6km×8km)

I: South of 25 de Mayo (10km × 10km)

J: San Ramon (the eastern extremity of the area : 10km × 5km)

The western part of the San Jose area (1 mineral showing)

K: San Carlos (21km × 13km)

The Arroyo Grande area (2 mineral showings)

L: Rio Negro I (10km × 15km)

M: Rio Negro II (25km × 10km)

The gold-bearing quartz vein is impregnated with basement complex (pCCcb), ancient granite intrusive rocks (pCCG) and greenstone (pCCps, pCCsj, pCCag and pCCsjo). Regarding the wall rock alteration, it is megascopically recognized that both granites and greenstone of the wall rock have been subjected to silicification, chloritization and epidotization at the edge of the quartz vein. According to the result of X-ray diffractive analysis, it is estimated that from the edge of the quartz vein outwards, the mineral assemblages consist of quartz – sericite – (pyrite) and chlorite – epidote – (albite).

As for the occurring appearance of quartz veins, the vein width comes to several to dozens of meters in basement rocks, greenstone and ancient granitic rocks, while it declines extremely to several millimeters to centimeters in younger granite intrusive rocks (pCC). It is considered that pCC had some bearing on the gold mineralization. In the wall rock around the pCC body, quartz veins are well developed. However the geological information of pCC as directly associated igneous rocks was not obtained. Assuming a series of ore-forming processes, the following causes are estimated as reasons for diminution of quartz vein width in pCC.

The lithologic character of pCC is inhomogeneous, when compared with pCCG. Large fissures were hardly formed because creeping deformation occurred due to its high ductility. Conversely, fractures with a moderate width could not be formed because brittle deformation occurred due to its low ductility.
As for the disposition pattern of the quartz vein, two preferred directions of the veins are observed; the NE-SW to E-W and the NW-SE. The former is approximately concordant with the large-scale fracture zone displaying left lateral slip, while the latter displays right lateral slip sense owing to the left echelon disposition. Faults with the same sense are developed along with the latter veins. It is considered that the NW-SE faults can be a conjugate set with the NE-SW to E-W veins.

According to the result of the polished section observation of both quartz vein and the wall rock of the deposit, ore mineral was hardly found in the quartz vein except a little limonite and partially an infinitesimal amount of pyrite. A small amount of pyrite – (chalcopyrite) dissemination was recognized in green rocks and some of quartz vein. According to the assay result, the maximum assay value was 19,890ppb.

From the lithologic character of the quartz vein, it was classified into three types, milky sugar-like translucent quartz, colorless to white transparent quartz and gun metal transparent quartz. Considering the zonal distribution, which is locally recognized, and their appearance of interpenetration, it is estimated that these different stages of each quartz type become recent in this order in a chronological relationship.

As the result of the fluid inclusions analysis, the homogenization temperature was estimated to be

447.7°C at the highest and 85.6°C at the lowest, and the histogram usually had three peaks at around 300°C, 250°C and 200 to 150°C, which could be considered to correspond to milky translucent quartz, colorless to white transparent quartz and gun metal transparent quartz, respectively. According to the result of measurement, the salinity was 4.2 to 35% (NaCl % equivalent), which indicates a coexistence of both quartz formed under high and low pressure.

Considering which type of quartz is accompanied by Au, no characteristic depending on the mineral showing is recognized. It seems that Au is apt to accompany colorless to white transparent quartz and gun metal transparent quartz. In addition to these types, black quartz also occurs which contains clay minerals (phyllosilicate) difficult to identify. Consequently it is necessary to analyze more carefully in detail to be able to discuss the ore-forming stage of quartz accompanied by Au.

1-2 Geochemical prospecting

(1) Soil geochemical prospecting

2,021 soil samples of weathering and pedologic paleostream sediment, were chemically analyzed for 34 elements (Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Co, Cu, Ga, Fe, La, Pb, Mg, Mn, Hg, Mo, Ni, P, K, Sc, Ag, Na, Sr, S, Tl, Ti, W, U, V, Zn and Au). Based on the result, bivariate and multivariate analyses were implemented, after statistically processing the data to obtain the key statistics.

As the result of a bivariate analysis, the Au anormaly zone was extracted from the mineral showings H and L, while the As anormaly zone was extracted from the B, E, G, northern part of G, H, I and the eastern part of K, L and M. As the result of a multivariate analysis (factor analysis), factors were extracted which could be associated with the Au mineralization and with the rock properties of mafic rock and granites.

Factor1 : Co, Cr, Cu, Fe, Mg and Ni

Factor2 : Ga, Al, Fe, K, Li, Pb, Y and Zn

Factor3 : Ca, Na and Sr

Factor4 : Au, As, K and V

When examining the relation between the soil geochemical anormalies and the mineralized zone, the mineral showings A, B, E, G, H and L stood out as the place which the anormalies of Au and As, and high score zone of Factor4 had been duplicated. According to the result of soil geochemical prospecting, and as a result of this fiscal year's survey, the possibility of bearing a potential gold ore deposit is sufficiently recognized.

(2) Rock geochemical prospecting

607 rock samples of quartz vein and wall rock were chemically analyzed for 8 elements (Au, Ag, Cu, Pb, Zn, As, Sb and Hg). According to the result of the assay, the following samples were extracted as Au anormary; 23 samples taken from quartz vein which contains relatively high grade ore with the maximum assay value of 19,890ppb, and 18 samples taken from green rocks and granites which contains relative low grade ore. The assay value of quartz veins impregnated with green rocks was in a range of 5ppb to

19.890ppb, and that of granites was 5,370ppb to 37ppm, while that of other rocks was 14ppb to 562ppb. Regarding the assay result of the wall rock, the assay value of green rocks was 5ppb to 37ppb, and that of granites was 9ppb to 291ppb, while that of other rocks was 9ppb to 354ppb.

As the result of a bivariate analysis, the Au anormaly zone was extracted from the mineral showings B, E, G, J, K, L and M as well as the mineral showing A around the Mahoma mine. As the result of a factor analysis, factors associated with the Au mineralization and rock properties were extracted.

Factor1 : Cu, Zn and As

Factor2 : Au and Ag

Factor3 : Pb and Zn

Examining the relation between the rock geochemical anormalies and the mineralized zone, the mineral showings A, E, G, H, K and L loomed up as the place which the anormalies of Au and As, and high score zone of Factor 2 had been duplicated.

1-3 The ore-bearing potential

A gold-bearing quartz vein deposit associated with fracture zone is expected because of such aspects as the structural control recognized in the ore deposit, several ore-forming stages exist, the Au content is not partialized in a specific rock, and related igneous rock is hardly determined. Basically it can be considered that the ore-forming fluid containing Au (the origin of Au is unknown) had ascended along the NE-SW to E-W trending fracture zone and the NW-SE trending fracture zone as a conjugate sets, and then Au had precipitated on an oxidation-reduction condition.

According to the result of rock geochemical prospecting, the particularly high Au content was obtained in the quartz vein of the mineral showing A involving the Mahoma mine. Geochemical anormalies were extracted at the mineral showings B, E, G, J, K, L and M. According to the result of soil analysis, there were many samples which indicated the Au and As anormalies, in mineral showings A, B, E, H and L. Geological descriptions including mode of occurrence and scale of each mineral showing, the result of laboratory experiments and analyses and, a comprehensive evaluation are summarized in Tab. I-5-1. The location of each mineral showing is plotted on the geological map along with the Au anormalies (Fig. I-5-1). As a result, geochemical anormalies of Au were extracted along the shear zone in the mineral showing A, while they were also extracted near the shear zone in the mineral showings B, E, K and L. Consequently, the possibility that gold ore deposit would exist along the shear zone is high.

CHAPTER 2 RECOMMENDATIONS FOR THE SECOND PHASE

Among the above-mentioned object survey area, the most promising areas expected to bear ore deposit were conclusively extracted and marked as the recommendation area with lines in red on the map (Fig. I-5-1), after the geochemical anormaly area was extracted by soil and rock geochemical analysis, and data obtained through various analyses was comprehensively analyzed. It is considered that the following prospecting methods are effective for these promising areas. Comprehensive evaluation in ranks from A to D to define priority and an effective prospecting method are indicated in Tab. I-5-1.

①Mineral showing A, including surrounding area of Mahoma mine : detail geological survey and rock geochemical prospecting, complete soil geochemical prospecting, and

②Mineral showings H to G : detail geological survey and rock geochemical prospecting and, complete soil geochemical prospecting.

③Mineral showings L to partial M: detail geological survey and rock geochemical prospecting and, complete soil geochemical prospecting

④Mineral showing B : detail geological survey and detail complete geochemical prospecting

⑤Mineral showing E : detail geological survey and detail complete geochemical prospecting

The detail of the prospecting methods are discribed as follows.

①Detail geological survey and rock geochemical prospecting (including trenching for quartz vein prospection at inappropriate outcrop)

②Complete soil geochemical prospecting (10 samples/km^2: randam sampling is effective being compared with grid sampling, because the vegetation is relatively luxuriant near a river.).

The result of Phase I was obtained from limited amount of outcrops, so it necessary to implement the airborn geophysical for prospect a wide area.

From the field prospecting of this year the high potential zone was recognized extending widely to the southwestern field of Mahoma Mine, consequently it is recommended that geochemical prospecting of riverside weathered soil should be implemented over a 100km^2 area.

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