Alteration and Vein Textures Associated with Gold Mineralization at the Bunikasih Area, Pangalengan, West Java

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Abstract

The Bunikasih vein system in the Pangalengan district of West Java is a low-sulfidation, adularia sericite epithermal gold deposit. It is hosted by Late Miocene andesitic volcanic and volcanoclastic rocks occurring in the south western margin of Malabar Volcano complex. Gold ore and alteration minerals related to deposition of gold in Bunikasih deposits superimposed on Late Tertiary-Quaternary andesitic formation that were altered and mineralized by some hydrothermal events. The veins consist almost entirely of quartz, with small amounts of adularia, bladed calcite, pyrite, and gold. Gold ore shoots are vertically restricted and are more continuous horizontally. The veins display complex and multi episodic filling with texture characteristics of open space precipitation such us colloform, lattice bladed, crustiform banding, vugs, breccia, and cockade and comb texture. The presence of bladed calcite and silica pseudomorph after bladed calcite suggests that the hydrothermal fluids boiled. In the Cibaliung section of the area, anomalous gold is related to veins trending northeast - southwest, milky quartz with dark grey to black manganese staining is found intermittently for a length of about 800m. The mineralized andesite ore bodies exhibit broad alteration patterns adjacent to mineralization, passing from fresh rock into anargillic, chlorite zone, and then sericite-silica close to mineralization. An argillic assemblage composed of kaolinite with fine-grained pyrite bulb is present in the upper portions and surrounding of the quartz vein system. The veins range from centimeter to meter in size. Of 24 vein samples collected, gold averages up to 0.3 grams per tone ("g/t"), to a high of 24.6 g/t. The Bunikasih epithermal gold deposit was mined by people for more than 10 years, mainly for the gold ore.

Keywords: alteration, vein texture, gold mineralization, Bunikasih

Sari

Urat-urat yang terdapat di Bunikasih, Kecamatan Pengalengan, Jawa Barat, merupakan bagian dari suatu endapan emas tipe epitermal adularia serisit, sulfidasi rendah. Endapan emas tersebut terdapat dalam batuan vulkanik andesit dan batuan klastik vulkanik berumur Miosen Akhir yang terdapat di barat daya kompleks gunung api Malabar. Emas dan mineral alterasi penyerta dijumpai mengubah satuan batuan andesit Tersier Akhir – Kuarter yang telah mengalami alterasi hidrotermal. Urat-urat yang dijumpai tersusun oleh kuarsa dengan sedikit adularia, bilah-bilah kalsit, pirit, dan emas. Endapan emas dalam urat penyebarannya terbatas secara vertikal, dan relatif lebih menyebar secara horizontal. Urat-urat kuarsa memperlihatkan tekstur kompleks yang menunjukkan pengendapan berulang secara episodik dalam ruang terbuka seperti koloform, mineral berbentuk bilah, perlapisan crustiform, breksi, dan tekstur cockade and comb. Dijumpainya bilah-bilah kalsit dan pseudomorph silika hasil ubahan bilah kalsit menunjukkan kemungkinan terjadinya pendidihan (boiling) pada larutan hidrotermal. Di daerah Cibaliung, keterdapatan emas berasosiasi dengan urat-urat kuarsa berwarna putih susu berarah timur laut – barat daya sepanjang sekitar 800 m, dengan bercak-bercak mangan berwarna abu gelap hingga hitam. Batuan vulkanik andesit yang termineralisasi memperlihatkan pola alterasi yang berangsur dari batuan tak terubah menjadi zona argilik dan klorit, dan kemudian menjadi zona serisit-silika mendekati

Naskah diterima 21 Juni 2010, revisi kesatu: 13 Agustus 2010, revisi kedua: 02 September 2010, revisi terakhir: 26 November 2010

zona mineralisasi. Urat-urat kuarsa mempunyai lebar bervariasi dari sentimeter hingga meter. Dari dua puluh empat percontoh yang dianalisis, kadar emas rata-rata adalah 0,3 g/t, dan dapat mencapai 24,6 g/t. Endapan emas Bunikasih telah ditambang oleh penduduk setempat selama lebih dari 10 tahun.

Kata kunci: *alterasi, teksture urat, mineralisasi emas, Bunikasih*

Introduction

Bunikasih area is located about 60 km to the south from Bandung, southwest of Situ Cileunca, or about 15 km from Pangalengan (Figure 1). It is part of West Java Southern Mountain Zone covered by Quaternary (Pleistocene) volcanic rocks, known as Waringin Andesite unit (Alzwar *et al*., 1992). Based on a more detailed work by Chandra (2009), the andesite unit can be subdivided into three subunits; they are (older to younger): Cibaliung, Cikabuyutan, and Puncak Cacing andesite lava units. Gold mineralization was firstly discovered in early 1990 by exploration of PT. Aneka Tambang. Due to the small or subeconomic gold reserve, PT. Aneka Tambang has not mined this prospect. However, relatively high gold grade (up to 20ppm Au) in some quartz veins made a great interest to many local people to dig and mine gold traditionally. The Bunikasih epithermal gold deposit of Pangalengan, is one of small scale oberating gold mines, located in the southern part of West Java. The others being Cineam and Salopa - Tasikmalaya, Cikondang-Cianjur, and Gunungpeti - Sukabumi (Widi *et al*., 1997). Based on these occurrences and the overall volcanic setting, the southern belt of West Java has a good potential for discovering new gold ore deposits. For example, Pongkor Mount in Bogor associated with the southern volcanic belt, is the largest gold deposit in Java Island of which during more than 10 years has been mined by PT. Aneka Tambang (Warmada, 2003).

Geology of the Bunikasih Area

Based on a topographic map analysis and field observation, there are five identified (strike-slip) faults in the area. Two faults are NE-SW and the others are NW-SE (Figure 1). They are interpreted to be formed in post-Pleistocene, as they extend across Quaternary (Pleistocene) volcanic rocks. Based on regional geological study, the faults in the researched area are most likely parts of, or are influenced by, regional, NE-SW trend, dextral strike-slip faults, as identified by Alzwar *et al*. (1992). These regional and local faults are interpreted to be formed by a relatively N-S regional stress, which has been active since Late Oligocene – Early Miocene (Alzwar *et al*., 1992).

The Cibaliung andesite lava unit was observed along the Cibaliung River (Figure 2 and 3) and is characterized by whitish or greenish colour, and porphyritic textures, comprising phenocrysts of plagioclase and pyroxene in abundant aphanitic groundmass. Petrographic observation revealed that the aphanitic groundmass consists of minute crystals of pyroxene, plagioclase, glassy materials and opaque minerals. This unit shows a strong argillic and/or prophilitic alteration and, locally, silicification. In some places, a weak magnetic nature of this unit can be detected by magnet. Quartz veins in various sizes (1 cm to 3 m) are commonly present, crosscutting this unit.

The Cikabuyutan andesite lava unit is present along the Cikabuyutan River (Figure 2 and 3) and is characterized by black colour, porphyritic textures that show plagioclase and pyroxene phenocrysts in an aphanitic groundmass, and by its very strong magnetic nature. Phenocrysts in this unit are more abundant than those of the Cibaliung andesite lava unit. Very fine pyroxene, plagioclase crystals, and glassy materials constitute the aphanitic groundmass. The Cikabuyutan andesite lava unit is weakly altered by clay mineral (argillic), and unlike the previous unit, this unit is crosscut by small-sized quartz veins (< 1 m-wide).

Puncak Cacing andesite lava unit is the youngest unit in the area and is found in Puncak Cacing Hill as well as along some branches of the Cikabuyutan River near Puncak Cacing (Figure 2). This unit shows gray colour and comprises abundant phenocrysts of pyroxene and plagioclase in an aphanitic groundmass, which consists of fine

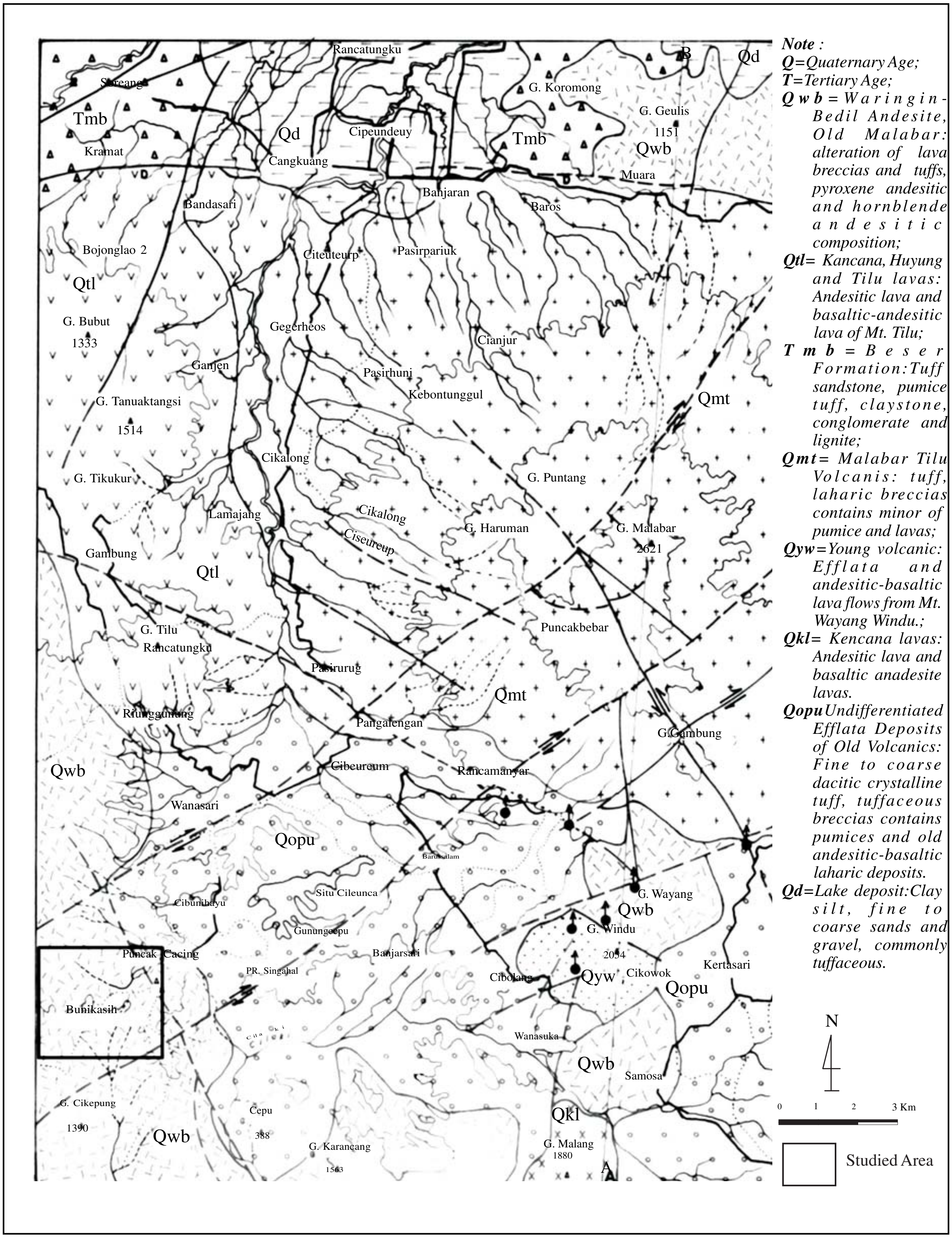
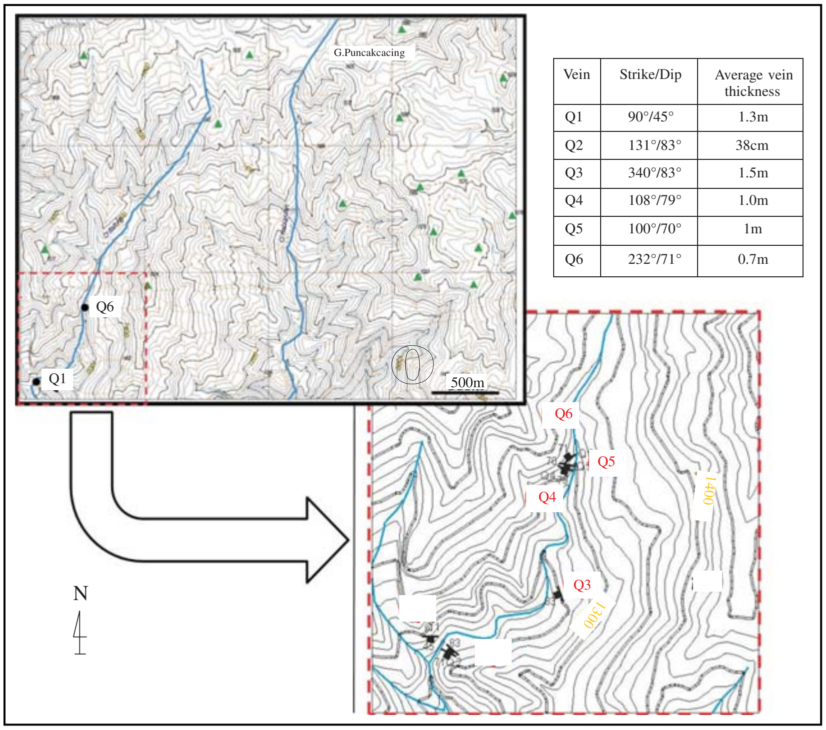


Figure 1. Simplified map western part of Geological Map of Garut and Pameungpeuk Quadrangle (Alzwar *et al.,* 1992). Bunikasih (boxed area) is located near Lake Cileunca and Wayang Windu geothermal field. Mt. Malabar is located in northeastern part.



Vein	Strike/Dip	Average vein thickness
Q1	90°/45°	1.3m
Q2	131°/83°	38cm
Q3	340°/83°	1.5m
Q4	108°/79°	1.0m
Q5	100°/70°	1m
Q6	232°/71°	0.7m

Figure 2. Topography map of Bunikasih area. Mt. Puncak Cacing is the highest landmark of this area. Gold mining is distributed on quartz vein group on southwestern area.

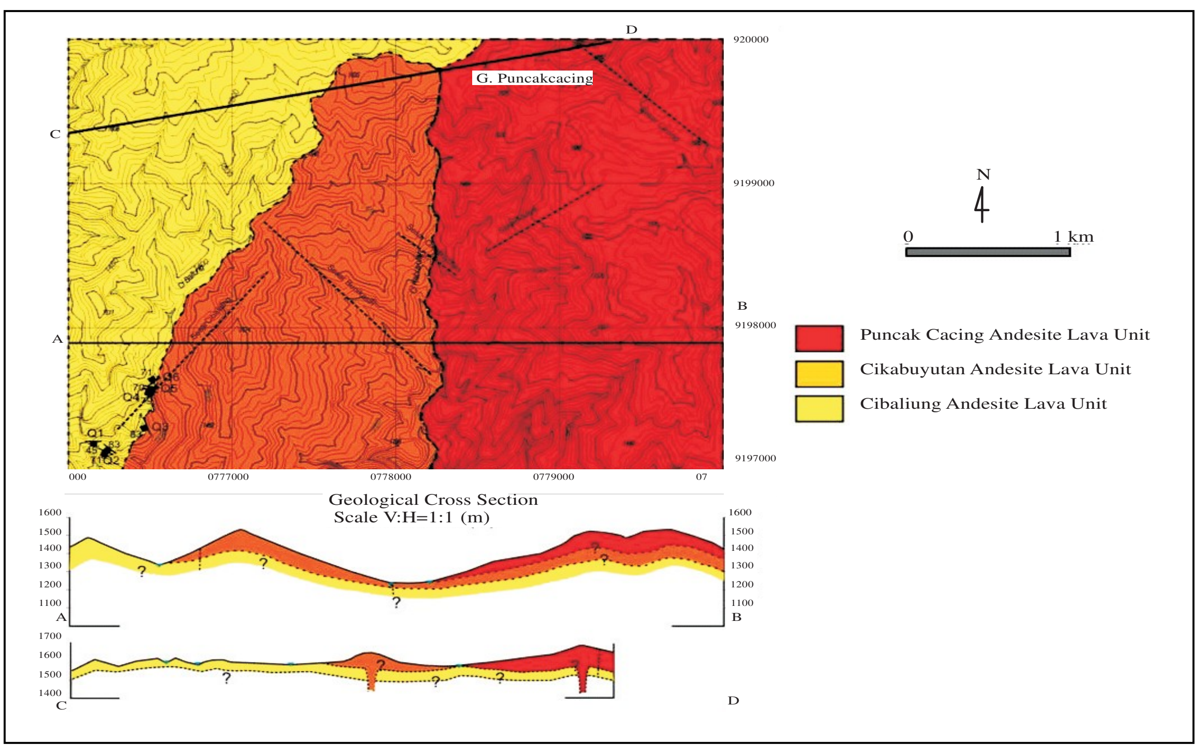


Figure 3. Simplified geological map of Bunikasih area (Chandra, 2009).

plagioclase and pyroxene and glassy materials. The lava unit is relatively unaltered and is weakly magnetic.

Alteration of Volcanic Rocks

Argillic and prophilitic are the common alteration types found in the area, with argillic occurrences are much more widespread than prophilitic (Figure 4). Argillic alteration on volcanic rocks is characterized by clay mineral alteration (probably kaolinite) after primary minerals and gives the altered rocks a feel like soap. Plagioclase and pyroxene phenocrysts, as well as groundmass materials show various degrees of alteration by clay minerals, with plagioclase in general show more intense alteration. Prophilitic alteration is characterized by the presence of chlorite, epidote, and calcite after phenocrysts of pyroxene, and plagioclase, and groundmass. Quartz is commonly present in argillic and prophilitic altered rocks, accompanying clay minerals, chlorite, epidote, and calcite. In general, primary textures of the rocks can still be identified. The intensity of alteration decreasing from the Cibaliung lava unit (medium to strong) to the Cikabuyutan lava unit (weak to medium) to Puncak Cacing lava unit (weak), gives an apparent systematic alteration intensity which decrease from west to east.

Quartz veins in the area are mainly found in the Cibaliung lava unit. The veins can have simple to complex textures, occurring in various sizes (wide). Micron-sized gold particles are known to be present in quartz veins. The veins have been the primary target for local miners to extract gold. The general trends of some of the studied quartz veins are consistent with the trends of faults in the researched area, suggesting structural control on vein formation. The faults have probably acted as conduits for hydrothermal fluids that were responsible for alteration of volcanic rocks and formation of quartz veins.

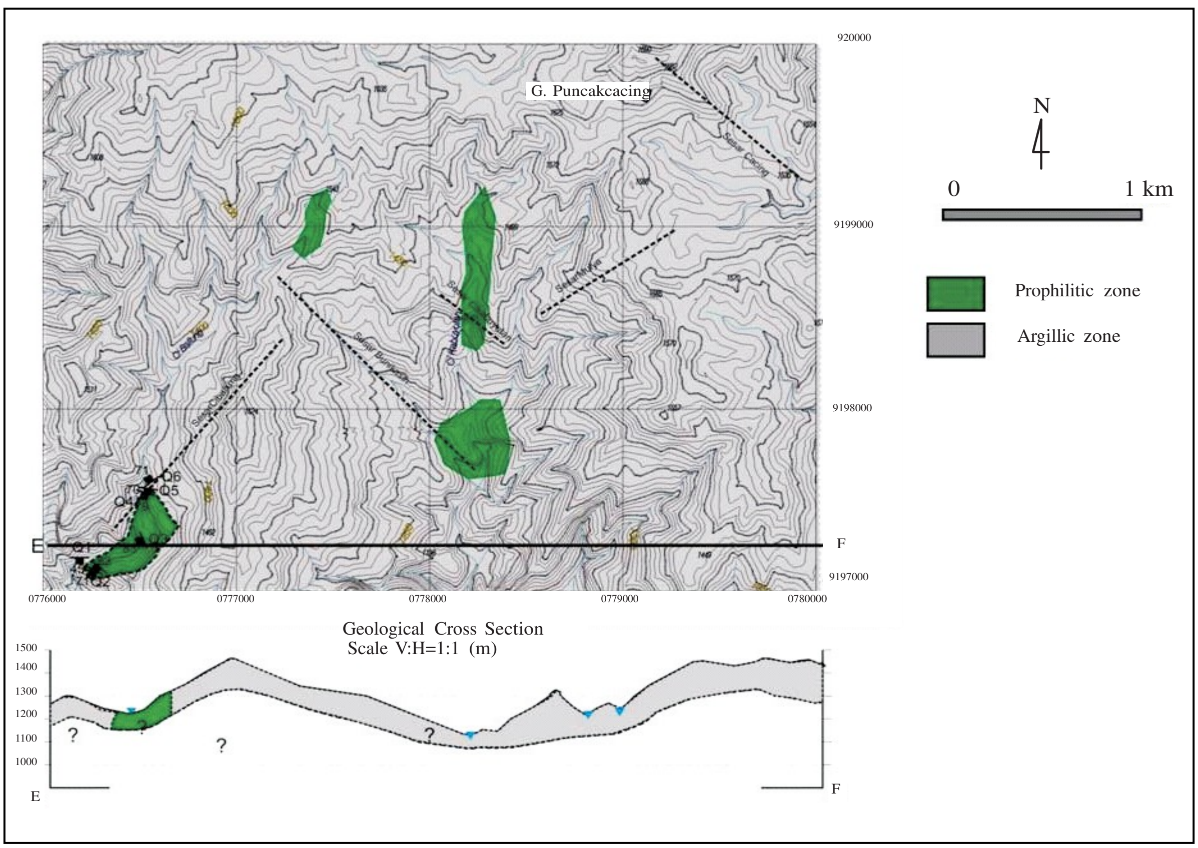


Figure 4. Simplified alteration map of Bunikasih area (Chandra, 2009).

Morphology of Quartz

In epithermal systems, silica may be deposited as opal or amorphous silica, chalcedony or quartz (Morrison *et al*., 1990). All these phases, except quartz, were precipitated from solution that were supersaturated with respect to quartz, and then recrystallized to quartz with time because they were metastable at low temperatures (Fournier, 1985a). The quartz texture in veins may reflect the original conditions of silica saturation.

Classification of quartz textures in epithermal vein systems have been presented by many researchers since Adams (1920) first proposed a terminology for quartz. Recent studies have noted that quartz textures in epithermal gold veins can provide evidence about mineralization processes (Morrison, 1990; Dong *et al*., 1995).

Structural classes are defined by features such as colour, grain size, and crystal form (comb, fine grained, palty, colloform and cockade). Rhythmic symmetrical and asymmetrical crustiform banding is composed mostly of alternating band of quartz showing various structures. Textures classes are defined by features such as grain size and form of quartz. A summary for structure and texture types in quartz veins is provided in Table 1.

Methodology

The studied samples were taken from outcrops that represent different lithologic units and different alteration types, and quartz veins (see map on Figure 3). Hand specimen and thin section petrographic analysis were conducted to determine primary rock textures and compositions, as well as secondary minerals and textures. Several quartz vein samples are cut and polished for detailed texture and mineral paragenetic study. Geochemical analyses of selected veins were done by XRF instrument and Energy Dispersive Analysis of X-rays (EDAX), performed on laboratory of Geological Department of Free University Berlin – Germany.

Table 1. Classification of Quartz Structure and Texture

Texture type
Comb: a group of euhedral-subeuhedral crystals resembling the teeth of a comb under the microscope (2)
Feathery: a feathery and splintery appearance seen locally or throughout quartz crystals caused by slight differences in the maximum extinction position under the microscope (4)
Microcrystalline: aggregates of microcrystalline quartz
Fibrous: aggregates of fibrous quartz grains oriented perpendicular to the growth surface
Dendritic: branching patterns of quartz
Colloform: rhythmic bands of microcrystalline quartz on various scales (1)
Flamboyant: a radiant or flamboyant extinction of individual crystals with more or less rounded crystal outline (4)
Ghost-sphere: spherical distribution of impurities within microcrystalline quartz (4)
Pseudoacicular: linear arrangement of fine, elongate grains which could be caused by quartz replacement of calcite (4)
Structure type
Comb: a group of euhedral-subeuhedral crystals resembling the teeth of a comb (2)
Fine-grained: a group of anhedral quartz showing homogeneous grain shape; this structure is similar to the massive quartz texture defined by Dong *et al*. (1995)
Platy: aggregates of radial, bladed crystals (3)
Colloform: rhythmic bands of chalcedonic silica grains with reniform habit (1)
Cockade: concentric crustiform bands of quartz, surrounding isolated fragments of host rock, or earlier precipitated quartz, or both (2)

The terminology of the quartz structures and textures is based on:
(1) Rogers (1917)
(2) Adams (1920)
(3) Urashima (1956)
(4) Dong *et al*. (1995)

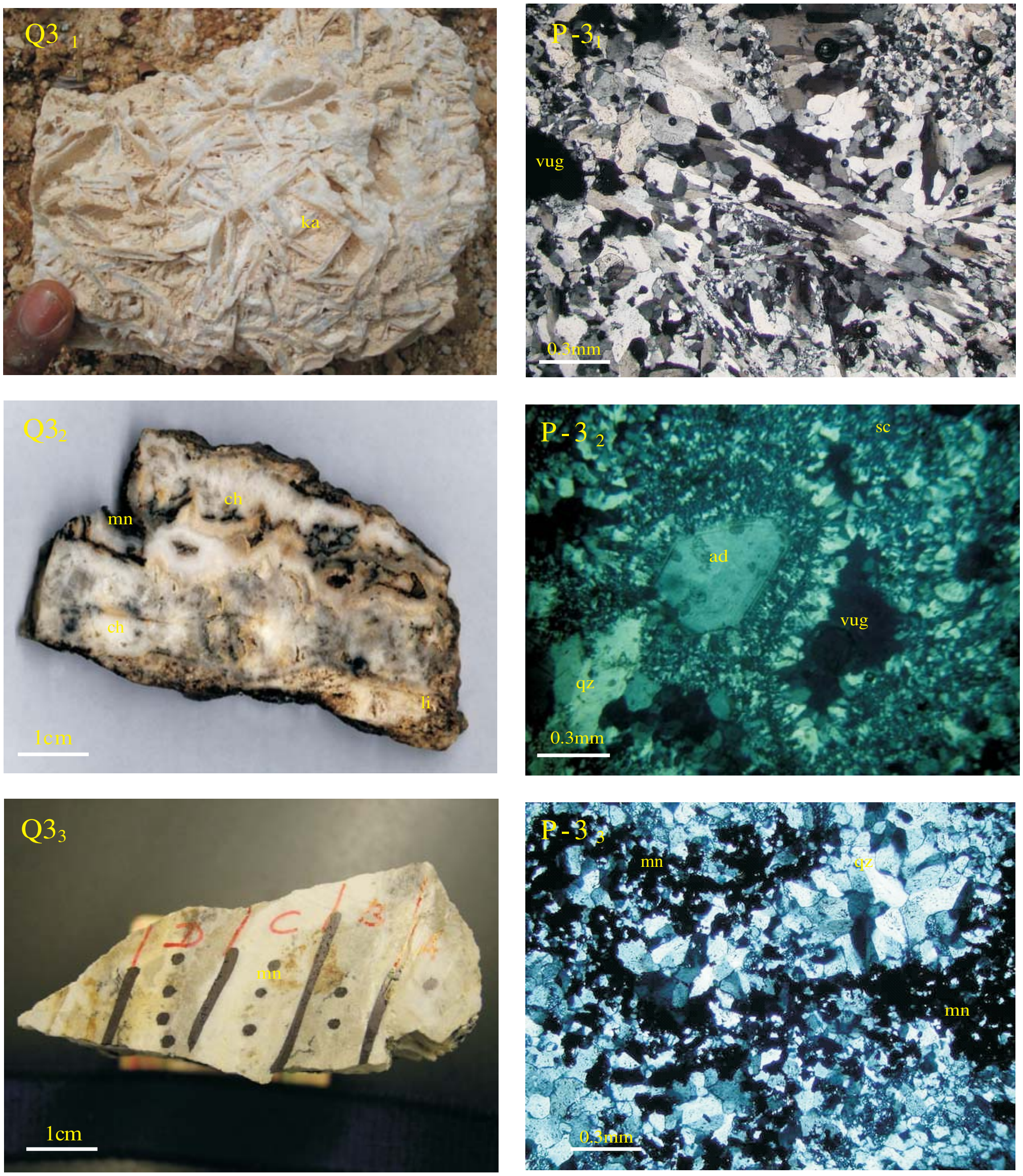
Results: Vein Petrology and Geochemistry

A classification of quartz veins at the Bunikasih mine was made based on textures and cross cutting relationship in the veins, adopting classification in Shimizu *et al*. (1998). The epithermal quartz veins are concentrated on the southwestern part of the researched area (Figure 2). The deposit occurs in a southwest-northeast shear zone within Late Tertiary-Quarternary volcanic rock. The mineralization can be divided into six major vein groups with general north-south Q4-Q5-Q6 (Q4-6 group) and northwest-southeast Q1-Q2-Q3 (Q1-3 group) strikes. Two groups of major vein show variable internal structure and texture as well as various gold and silver grade.

Based on crosscutting relationships and mineral paragenesis, the veins appear to have been formed during two mineralization epochs. The earlier event is located in the northern part of River Cibaliung, further divided into three stages Q4-Q5-Q6, whereas the rest in southern part can be distinguished in the later event Q-Q2-Q3). The wide veins consist of multiple mineralization stages. Relatively higher Au (4.0-24.6 ppm) and Ag-Cu-Pb-Zn contents are associated with the Q1-3 stage. The earlier mineralization stages are represented by Q4-6 vein group and characterized by 0.3-3.4 ppm Au and relatively lower base metal and silver content (Table 2). Vein group of Q1-3 shows an association texture of lattice bladed, crustiform-colloform banding, and ghost bladed in abundant milky white chalcedonic quartz with some intensively manganese and iron oxide stainings (Figure 5). Lattice bladed is a network intersecting blades of calcite separated by polyhedral cavities which originate as pseudomorph of lattice bladed calcite (Morrison *et al*., 1990). This lattice texture indicates a boiling zone in the uppermost level of epithermal system (Dong *et al*., 1995). Adularia content on this Q3 vein (Figure 5) is also supported for the boiling zone environment. Highest gold grade with relatively higher Ag-Cu-Pb-Zn-As-Sb content (Table 1) is associated with vein group of Q3 (20.1-24.6 ppm Au); this is characterized by creamy white ghost bladed chalcedony with light grey manganese oxide and sulfide staining (Figure 5). This highest gold content is detected by EDAX analysis showing an electrum image with significantly gold and silver peaks (Figure 6 and 7). Q2 vein shows a lower gold content (7.2-15.0 ppm), characterized by an associate texture of cockade and carbonate lattice bladed (Figure 8). Cockade is a typical texture showing concentric crustiform bands of quartz, surrounding isolated fragments of host rocks or earlier precipitated quartz or both (Shimizu *et al*., 1998; see Table 2). Rhodochrosite (Mn-carbonate) is often present in this Q2 group. The lowest grade of gold on group Q1-3 is Q1 vein, characterized by banded chalcedonic with abundant crystalline quartz and scarcely manganese staining (Figure 9). Lowest gold contents of the whole vein samples are associated with group Q4-6. This vein group is characterized by 0.3 to 3.4 ppm gold content, banded chalcedonic, cockade with saccharoidal core and crustiform-colloform bands

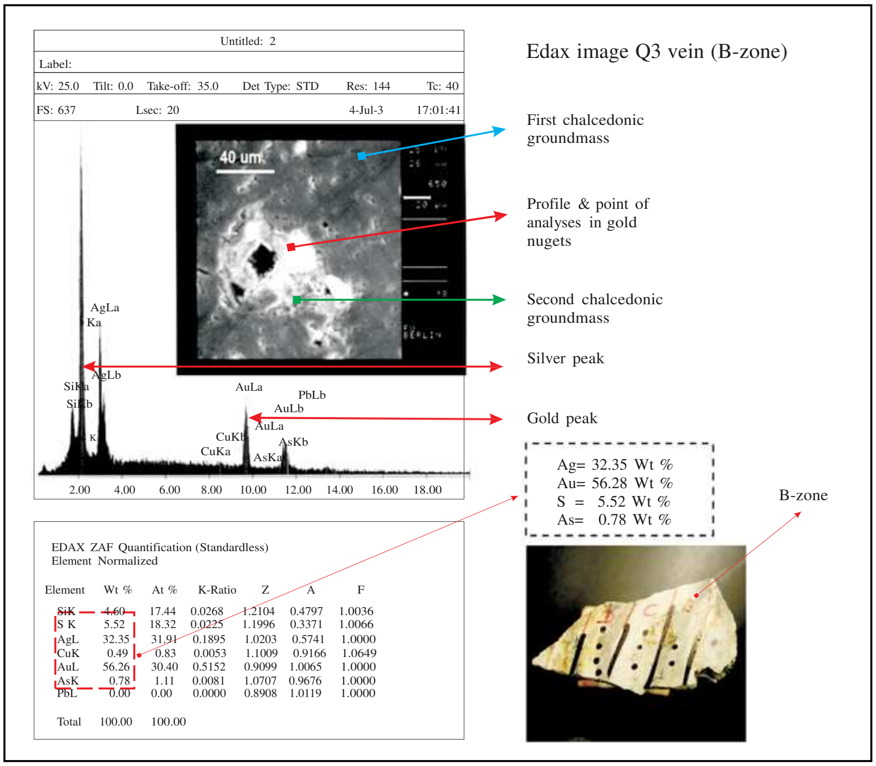
Table 2. Representative Composition of selected Quartz Veins of Bunikasih Area by ICP Analyses (in ppm). Analyses were performed in Geochemical Laboratory of Free University Berlin – Germany

Sample	Au	Ag	Pb	Zn	Cu	As	Sb	Fe
Q11	4	8	25	25	8	0	0	605
Q12	3.7	7	30	25	7	0	0	554
Q13	1	90	40	40	13	8	5	7186
Q14	1	79	50	50	12	7	5	6111
Q21	15	545	45	55	60	24	6	1000
Q22	17.4	518	40	60	60	25	6	1096
Q23	7.2	617	20	111	61	21	6	2074
Q24	7.7	554	15	95	50	22	5	1795
Q31	24.6	618	40	55	65	22	6	954
Q32	20.6	493	35	45	55	23	7	1005
Q33	20.1	1164	30	131	96	38	9	1516
Q34	24.6	1056	33	123	85	40	8	1516
Q41	3.1	172	19	52	11	7	6	2669
Q42	3.4	160	70	55	12	7	7	2655
Q43	2.5	5	14	51	13	2	1	1168
Q44	2.8	5	14	53	12	2	1	1294
Q51	1	0	85	30	25	0	0	796
Q52	1	0	85	25	25	0	0	850
Q53	0.3	0	61	50	45	1	1	1362
Q54	0.4	0	80	50	40	1	0	1157
Q61	0.8	58	19	19	14	2	2	1313
Q62	0.7	55	19	19	12	2	2	1139
Q63	0.8	73	29	88	10	11	10	14325
Q64	2.7	71	10	25	15	22	4	10398



Q3$_1$. Lattice bladed, Q3$_2$. Crustiform banding of comb structure, Q3$_3$. Ghost bladed with segmental zone for chemical and microprobe analyses; P3$_1$, P3$_2$ and P3$_3$ microphotographs series of petrography in cross polarized light of left side quartz veins. ***Note***: *ad=adularia, ca=calcite, ch=chalcedone, cqz=cryptocrystalline quartz, ka=kaolinite, li=limonite (or limonitic staining or coating), mn=manganese oxide, qz=quartz, rh=rhodochrosite*

Figure 5. Series of macro- and micro photographs of vein group Q3. Selected geochemical and microprobe analyses of the lowest photograph are available in Table 1 and Figures 6 and 7.



Element	Wt %	At %	K-Ratio	Z	A	F
SiK	4.60	17.44	0.0268	1.2104	0.4797	1.0036
S K	5.52	18.32	0.0225	1.1996	0.3371	1.0066
AgL	32.35	31.91	0.1895	1.0203	0.5741	1.0000
CuK	0.49	0.83	0.0053	1.1009	0.9166	1.0649
AuL	56.26	30.40	0.5152	0.9099	1.0065	1.0000
AsK	0.78	1.11	0.0081	1.0707	0.9676	1.0000
PbL	0.00	0.00	0.0000	0.8908	1.0119	1.0000
Total	100.00	100.00				

Figure 6. Energy Dispersive Analysis of X-ray (EDAX) image of electrum founded B-zone of vein Q3 (inset). The profile shows gold and silver peak significantly. Inset table displays relative percentage of the element.

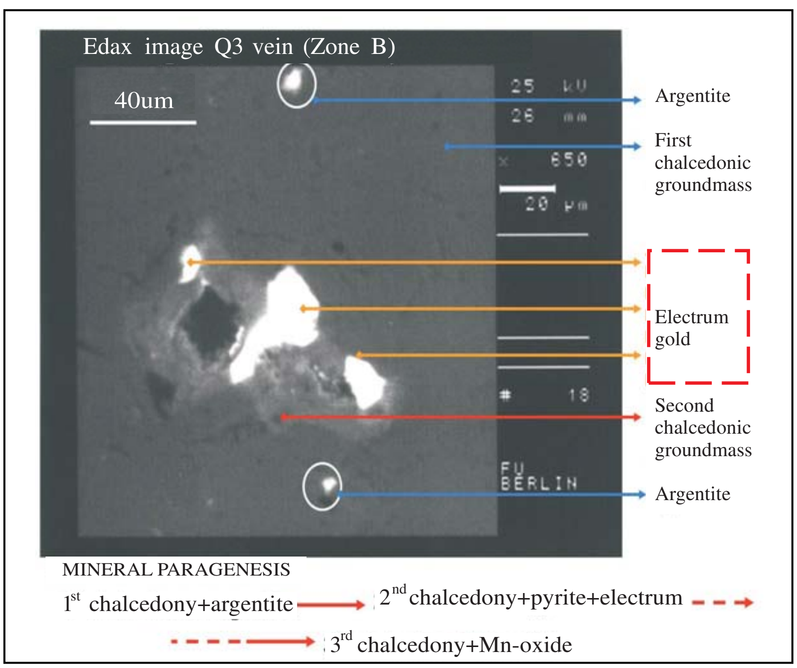
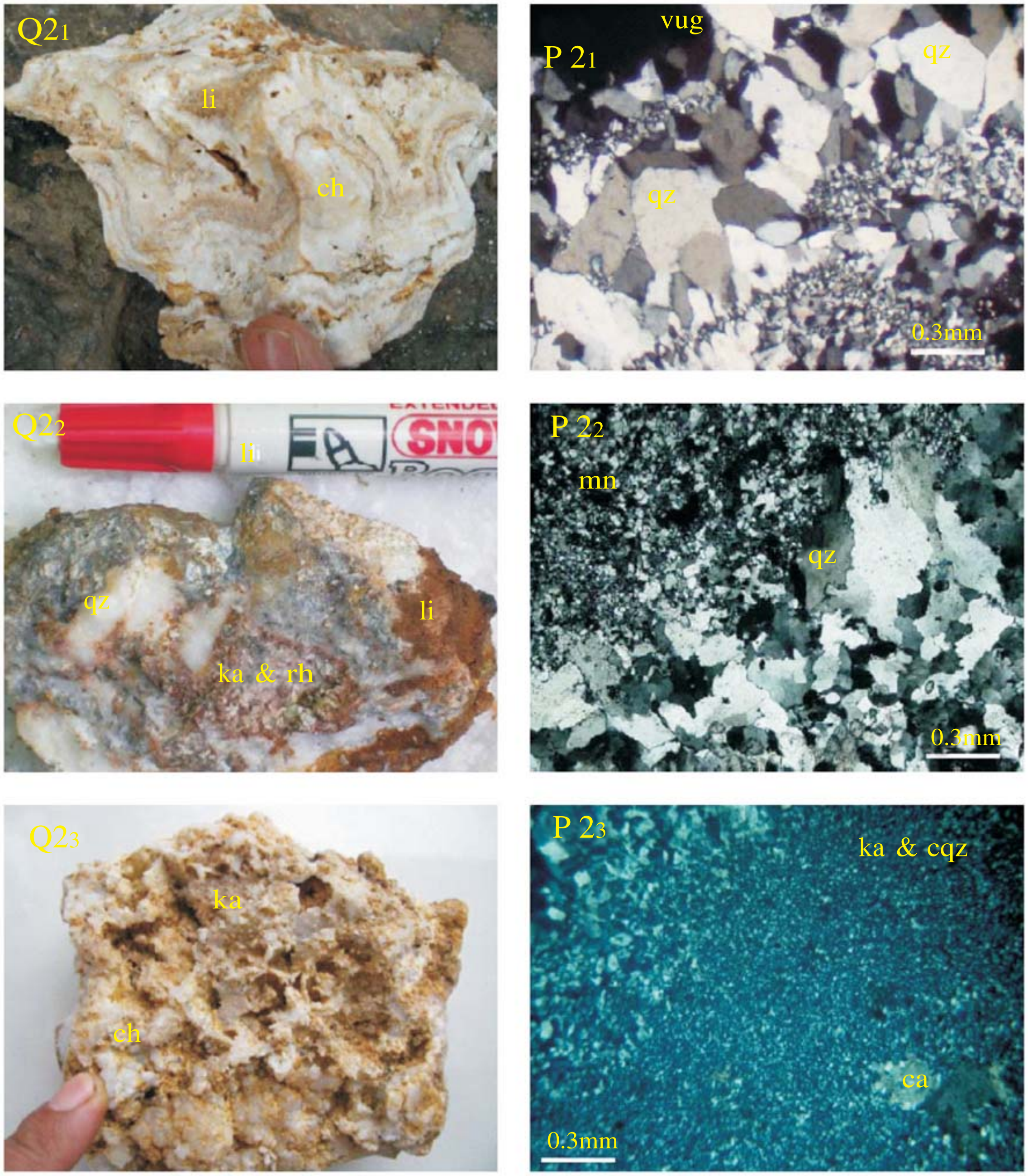
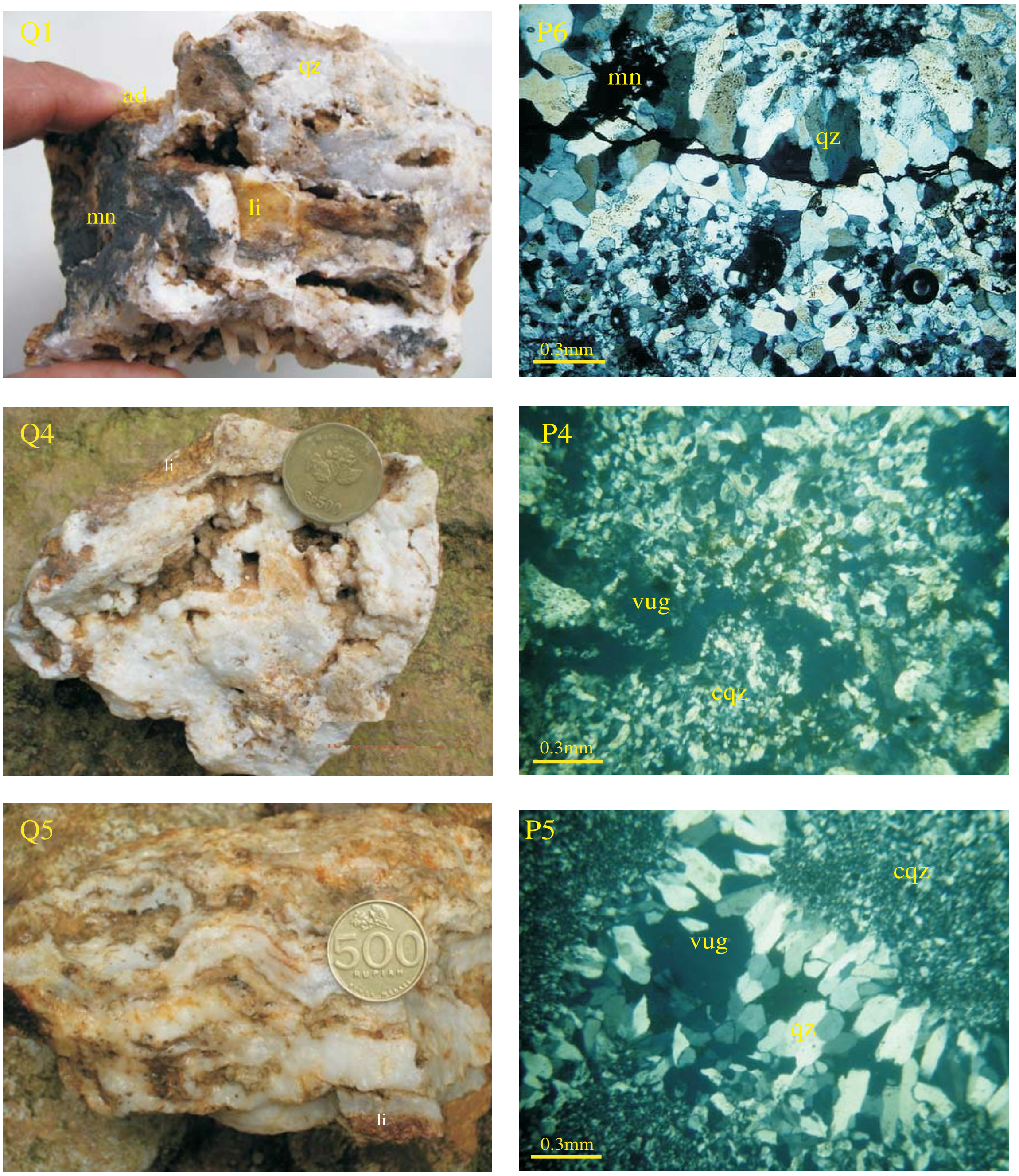


Figure 7. Detail microphotograph by EDAX imaging. The precious metals (Au & Ag) are associated with late chalcedonic veinlets (light gray in colour).



Q21. Cockade, Q22. Cockade with rhodochrosite vug infill, Q23.Carbonate lattice bladed; P21, P22 and P23 microphotographs series of petrography in cross polarized light of left side quartz veins.
Note: *ad=adularia, ca=calcite*, *ch=chalcedone, cqz=cryptocrystalline quartz, ka=kaolinite, li=limonite (orlimonitic staining or coating), mn=manganese oxide, qz=quartz, rh=rhodochrosite.*

Figure 8. Series of macro- and micro photographs of vein group Q2. Selected geochemical analyses of vein are available in Table 1.



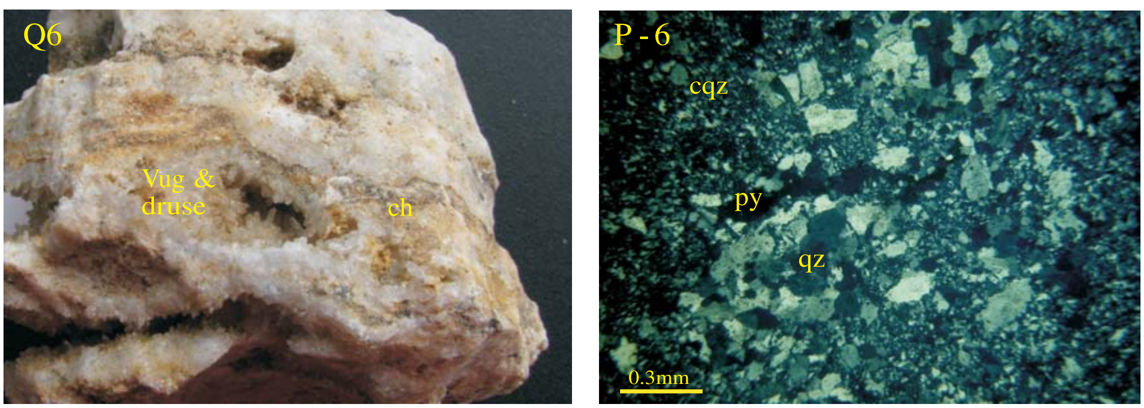
Q1. Banded chalcedonic with manganese film Q4. Cockade with saccharoidal core , Q5. Crustiform-colloform bands; P1, P4 and P5 microphotographs series of petrography in cross polarized light of left side quartz veins. ***Note***: *ad=adularia, ca=calcite*, *ch=chalcedone*, *cqz=cryptocrystalline quartz, ka=kaolinite, li=limonite (or limonitic staining or coating), mn=manganese oxide, qz=quartz, rh=rhodochrosite*

Figure 9. Series of macro- and micro photographs of quartz vein group Q1, Q4 and Q5. Selected geochemical analyses and microprobe profile and image of vein Q4 are available in Tabel 1 and Figure 6.

(Figure 9 and 10). The relative higher gold grade in this Q4-6 group is Q4 (3.4 ppm Au) detected by EDAX as a smaller electrum included in pyrite crystal (Figure 11). Significant different between group of Q1-3 and Q4-6 is the presence of lattice bladed texture and the colour as well as clarity of chalcedonic veins. The colour of Q1-3 group that has lattice bladed texture, shows milky white colour with light grey fleck or staining, whereas veins of group Q4-6 are dominated by crustiform texture with abundant glassy transparence appearance of crystalline quartz (Figure 10). A summary for characteristics of quartz vein in the Bunikasih area is provided in Table 3.

Discussion

In the Buchanan model of gold distribution (Buchanan, 1981) there are specific intervals that host base and precious metal mineralization (Figure 12). In the textural model, the precious metal interval essentially corresponds to the crustiform-colloform textural superzone and the base metal interval overlaps the crystalline chalcedonic zone, quartz, adularia and sulfide ore (Figure 12). Geochemical analyses of certain texture samples have demonstrated that within individual deposits there is a consistent grade range for each texture assemblage. For example, creamy white – light grey chalcedony with lattice and ghost bladed texture on vein Q1-3 has highest range of gold grade (> 1.0 to 24.6 ppm Au) and also shows by elevated of Ag-Pb-Zn-Cu-As-Sb. Light grey colour on the chalcedony is presumably due to relative higher content of base metal and manganese oxide. In contrast, the vein assemblage of Q4-6 displays more clear and transparent chalcedony or crystalline quartz with combination between banded chalcedonic, crustiform and saccharoidal textures showing relatively lower range of gold grade (0.3 – 3.1 ppm). High grades Au of Q1-3 is also characterized by the presence of adularia, sulfide bands, and manganese oxide in association with crustiform banding texture (Figure 3 on $Q3_2$ and $P\text{-}3_2$). Relative higher Cu-Pb-Zn-Mn is a good indicator for the presence of base metal in Q1-3.



Q6. Crustiform bands with vug and druse texture (lower right), P6 microphotographs series of petrography in cross polarized light of left side quartz veins.

Note:
ad=adularia, ca=calcite, ch=chalcedone,
cqz=cryptocrystalline quartz, ka=kaolinite, li=limonite (or limonitic staining or coating),
mn=manganese oxide, qz=quartz,
rh=rhodochrosite

Figure 10. Q6 is a representative of barren quartz vein and its petrography image. The colour of quartz is more clear and transparent than gold bearing milky quartz.

Table 3. Characteristic Features of Quartz Veins in the Bunikasih Area

Earlier mineralization epoch (Q4-6)
Characterized by development of barren comb texture quartz and few variations of quartz textures (comb-texture and microcrystalline quartz) Microcrystalline quartz partly associated with electrum in stage Q4 (Figure 7) Characterized by less developed crustiform bandings of comb- and fine-grained structure quartz compared to the later epoch Barren comb structure developed in stages Q5 (Figure 7) and Q6 (Figure 8) Fine-grained structure associated with manganocalcite (rhodochrosite) and johannsenite Cockade structure developed throughout stages
Later mineralization epoch (Q1-3)
Characterized by crustiform banding of comb-structure, fine-grained, platy, colloform, and cockade quartz Comb structure recognized throughout stages Colloform structure commonly observed in quartz of crustiform banding in stage $Q3_2$ (Figure 5) and in quartz showing botryoidal surfaces at stage $Q2_3$ Cockade structure commonly developed in stages $Q2_1$ and $Q2_2$ (Figure 6) Characterized by various textures: comb, feathery, microcrystalline, fibrous, dendritic, colloform, ghost-sphere, flamboyant, and pseudoacicular (Figure 5) Comb-texture quartz developed without ore minerals except stage $Q3_2$ and $Q3_3$; alternate precipitation of barren comb-texture quartz and microcrystalline quartz; growth bands developed in comb-texture quartz of stage $Q3_3$ and not in quartz from other stages Microcrystalline quartz intimately associated with ore minerals and interstratified chlorite-smectite in stage $Q3_2$ (Figure 5) Feathery texture apparently found as patches or zones in comb-texture quartz throughout vein formation Fibrous texture with colloform structure quartz developed in stage Q5 and Q6 (Figure 7 and 8) Colloform and flamboyant textures with fine-grained structure developed in stage $Q3_2$ (Figure 5) Dendritic quartz partly observed in comb-texture quartz (stage Q6) and microcrystalline quartz $Q2_3$) Lattice bladed and ghost-sphere texture is partly observed in microcrystalline quartz in stages $Q3_1$ and $Q3_3$

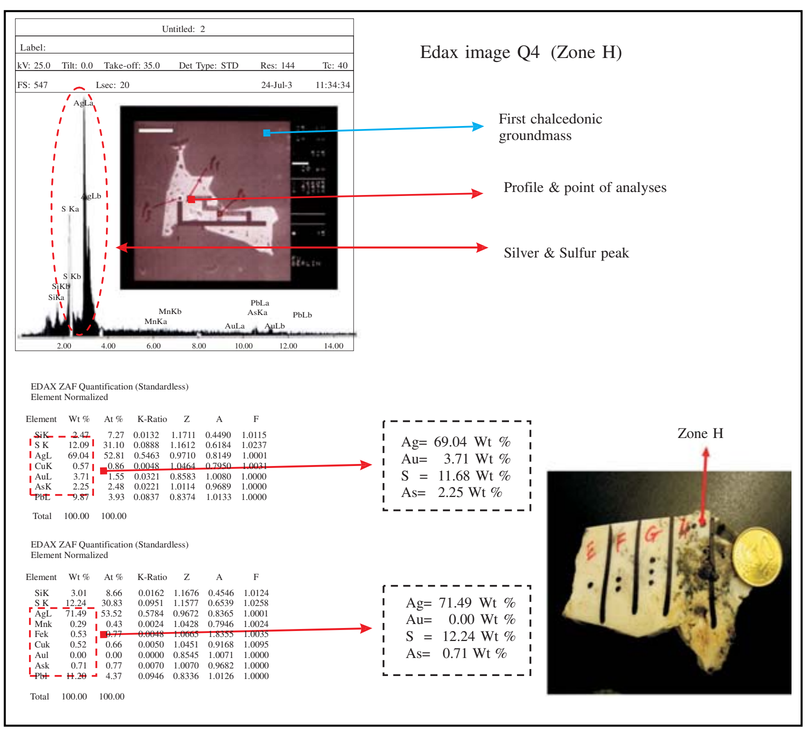


Figure 11. EDAX image of electrum founded H-zone of vein Q4 (inset). The profile shows gold and silver peak significantly. Inset table displays relative percentage of the element.

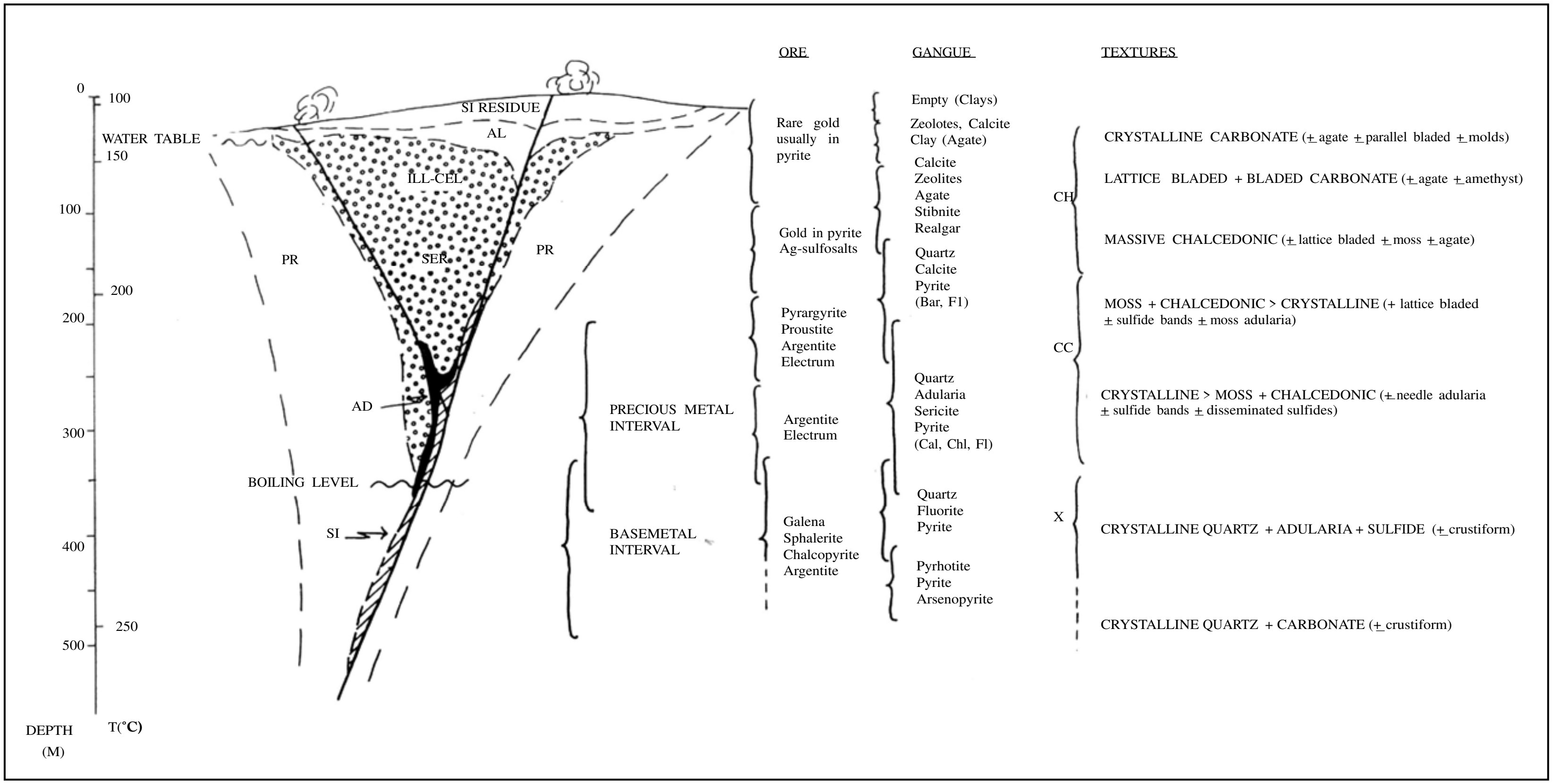


Figure 12. Scale model for zoning of textures, alteration, ore and gangue mineralogy in a typical boiling zone epithermal vein (op cit. Morrison *et al*., 1990). Based on the model of Buchanan (1981) with temperature reflecting the level for boiling under hydrostatic condition of a fluid containing 2.84% NaCl. Alteration zones PR=propylitic; SI=Silica; AD=Adularia; ILL=Illite; SER=Sericite; CEL=Celadonite, AL=Alunite, kaolinite, pyrite. CH=Chalcedonic, CC=Crustiform-Colloform, and X=Crystalline,

Conclusions

Quartz morphology combined with petrography and analyses of gold content by Energy Dispersive Analyses of X-ray (EDAX) studies suggest that boiling of the fluid occurred repeatedly, leading to silica-supersaturated conditions with respect to quartz and resulting in the formation of the certain silica textures. Recrystallization of silica to quartz occurred throughout vein formation. The geochemistry data combined with parageneses, quartz textures, and petrography studies suggest the following model for the Bunikasih gold-silver deposits. The veins show two distinct mineralization epochs, an earlier and a later one, which were responsible for type 1 (vein group Q4-6) and 2 (vein group Q1-3) hydrothermal fluids, respectively. Both types are dominantly meteoric water in origin. The most prospected gold in Bunikasih district is associated with vein group Q1-3. It occurs in the southwestern part characterized by the texture assemblage such as milky white chalcedony with often grey staining of manganese oxide and sulfide bands, lattice and ghost bladed, presence of adularia, and a relatively higher range of gold content between 1.0 to 24.6 ppm Au. Based on the systematic evaluation of the vertical and horizontal distribution of textures associated with an epithermal system (Buchanan, 1981), the vein group Q4-6 is associated with Crystalline Superzone or X-zone (Figure 12) and is characterized by common crustiform bands, dominantly clear crystalline and saccharoidal quartz, and also a general decrease in the proportion of sulfides and gold-silver content (see Table 1). The vein group Q1-3 is presumably mineralized in a higher level than Q4-6, deposited between the Crustiform-Colloform Superzone (CC) and Chalcedonic Superzone (CH). These CC and CH zones dominated by milky white chalcedonic quartz and associated with carbonate or bladed pseudomorph after carbonate, *e.g.* lattice bladed of sample Q3 (Figure 5) indicate the uppermost level and boiling zone in the epithermal system (Morrison *et al.*, 1990; Dong *et al.*, 1995).

Acknowledgements—The authors thank Prof. Dr. Peter Halbach of Free University Berlin for the technical support and permission to work in the laboratory for EDAX and ICP analyses during our visiting study in Marine Geology in Germany at 2003. The authors especially thank Julius Chandra, for the field work, report writing, and finishing thesis about gold mineralization in Bunikasih area. The authors also thank unit Geomin of PT. Aneka Tambang Tbk. for giving permission to visit the mining concession area in Bunikasih.

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