MINERALOGICAL CHARACTERS OF KARANG PANINGAL EPITHERMAL VEIN DEPOSITS, WEST JAVA

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ABSTRACT

Karang Paningal gold-ore deposits belong to the epithermal deposits. As hydrothermal deposits, the alteration that occurs in this area comprises argillitization, sericitization and silicification. The gold is included within several veins that perform three texture types, namely chalcedony, comb and vuggy. Based on its mineral contents and vein deposit types, mineralization at Karang Paningal took place in two stages that was early epithermal process producing comb-vuggy vein deposit and final epithermal deposit retaining chalcedony vein deposit. Zone of prospective mineralization takes place within vein and rocks beneath and above veins.

Keywords: gold-ore deposits, hydrothermal, epithermal, chalcedony, comb, vuggy, mineralization

INTRODUCTION

Gold deposit at Karang Paningal has been mined by small-scale miners for years that are administered by Village Unit Cooperative or known as *Koperasi Unit Desa* (KUD). The gold prospect was found in 1968 by several local gold miners. They came from Salopa – an area that is situated not far from Karang Paningal. Since then, the area is exploited by some scale gold minings that have been illegally carried out by several groups of local people until 1982 when the local government required those who involved in mining activities gathered and retained a mining license in the form of village unit cooperative. Though the ore deposits are prospective, mining activities could not run well. Miners have lack of skill in exploration techniques, mining development as well as financial system. As a result, gold processing does not reach maximum recovery.

Administratively, Karang Paningal area belongs to the Cineam District of West Java (Figure 1). It is included in 7°26'25" - 7°26'34" South Latitude and 108°21'22" – 108°21'31" East Longitude. The main objective of this study is mineralogical characters of the epithermal deposits that are exposed along Citambal River and surroundings, hence geological mapping was not conducted. A geological map made by Budhitrisna (1987) was employed as a reference (Figure 2) during the field work. Locally, the Karang Paningal area comprises volcanic breccias and dacitic lavas. However, surrounding the area also retains tuff unit (the oldest one) that is intercalated with dacitic lava and breccias, diorite and dacite. The potential areas of mineralization occur around Cikondang, Citambal and Ciseel.

Gold along with silver, lead, iron and zinc occurs within quartz veins that intrude the lava (Budhitrisna, 1987). The thickness of vein is available from few centimeters up to 60 cm, but local thickness can reach until 1 m. The average grade of gold is around 6 to 15 g / ton Au. Commonly, the high grade one is not more than 5 cm. Geological structures that might be affected mineralization include (shear) joints and fault structures with their general strikes and dips around N287-293°E/72-78° and N144-169°E/56-80°, respectively. Another geological structure that characterizes the area is a folding, namely an anticline.

Received : 01 December 2010, first revision : 01 April 2011, second revision : 19 May 2011, accepted : June 2011

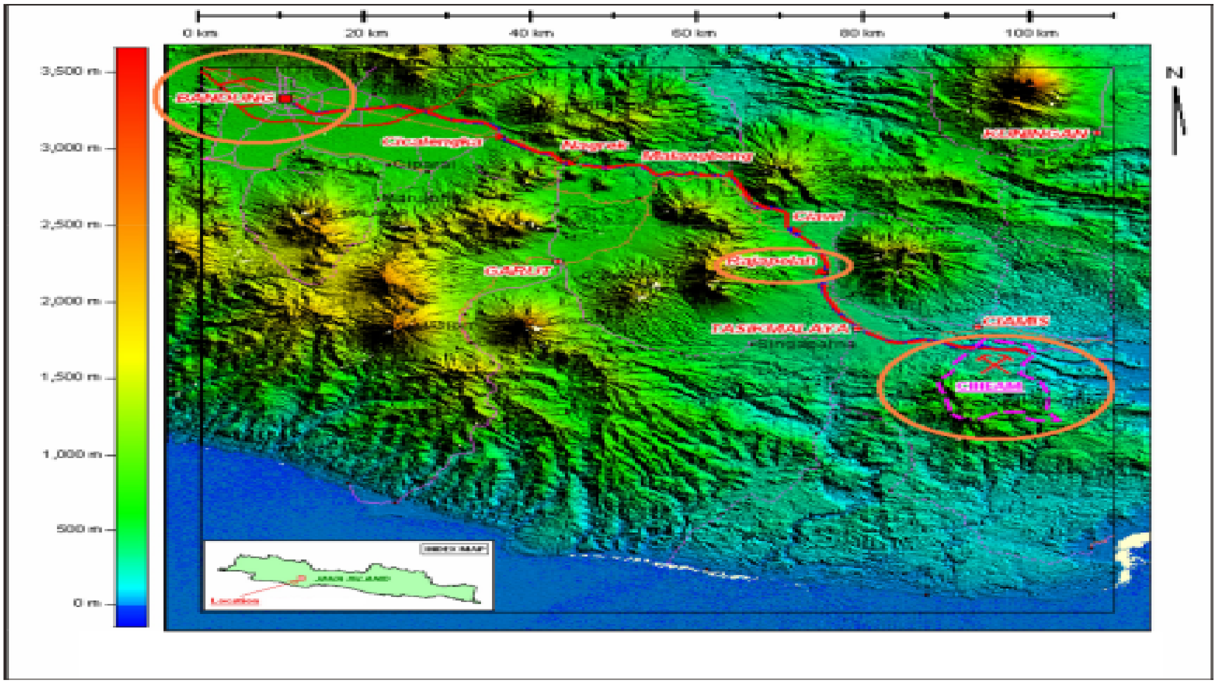

Figure 1. Location of study area that is included within Cineam District of Tasikmalaya

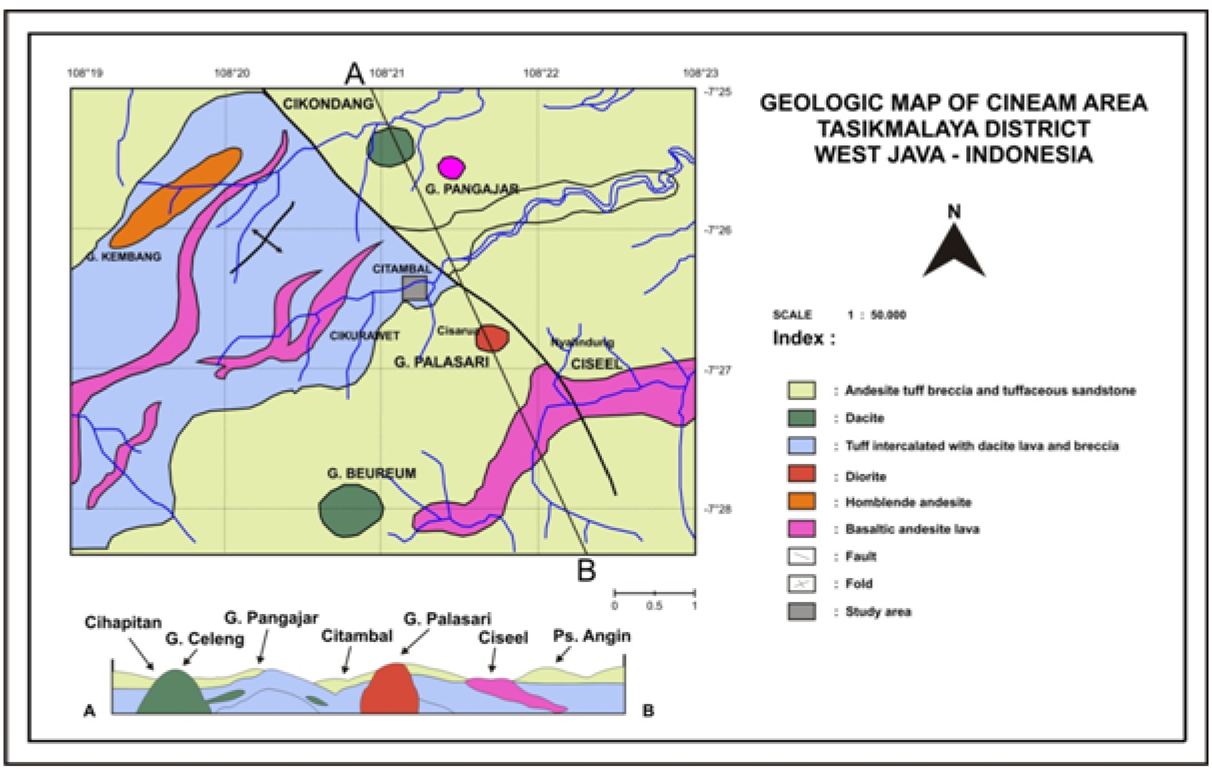

Figure 2. Part of Cineam geological map at which Karang Paningal is included within the area (modified from Budhitrisna, 1987)

METHODOLOGY

Field work was focused on selective sampling on various rocks for microscopic and geochemistry analyses. The sampling for laboratory purposes was conducted using a grab method, namely collecting a piece of rock from part of quartz vein and its host rocks (lava, volcanic breccias and tuff) at either above or under veins (Figure 3). Sampling was selectively conducted at each determined stations. The laboratory works included fire assay and optical microscope analyses for either thin or polished section analyses.

RESULTS AND DISCUSSION

The lithology of this studied area is mostly characterized by volcanic breccias and dacitic lavas, which belong to Jampang Formation (Bemmelen, 1949). The former takes place dominantly at the area and is commonly weathered while the later occurs alternately with the former. Breccias compositions consist of (commonly weathered) andesitic rocks and less sandstone. The andesitic rocks experience strong alteration, which is shown by the presence of alteration minerals such as quartz, sericite, clay, carbonate and ore minerals that replace the main minerals. Locally, it performs some veinlets that have strike and dip of N70-150°E/34-85°.

Performing aphanitic texture, dacitic lavas comprise plagioclase and pyroxene as main minerals. Though it alternates with the breccias, no baking effect found between both rocks. This means that the two rocks have the same age. The lavas are included within volcanic breccias that serve as a host rock. The rocks had experienced jointing which are then filled by hydrothermal solution to perform NW-SE quartz veins zone. The alteration minerals within this zone include sericite and carbonate minerals. Around 13 rock materials from different locations were sampled and prepared to 13 thin sections. Microscopic analyses of such sections show that the dacitic lavas had strongly been altered. The primary minerals within such rocks (plagioclase, pyroxene, amphibole, K-feldspar) change to alteration minerals this quartz, sericite, clay carbonate and ore minerals. Fountain (1972) stated that in such a condition not only did the hydrothermal solution change the main minerals but also it enriched dacitic lavas with several mineralizations. Pyrite, sphalerite, chalcopyrite, galena including gold and silver ores are the common metal minerals within this area.

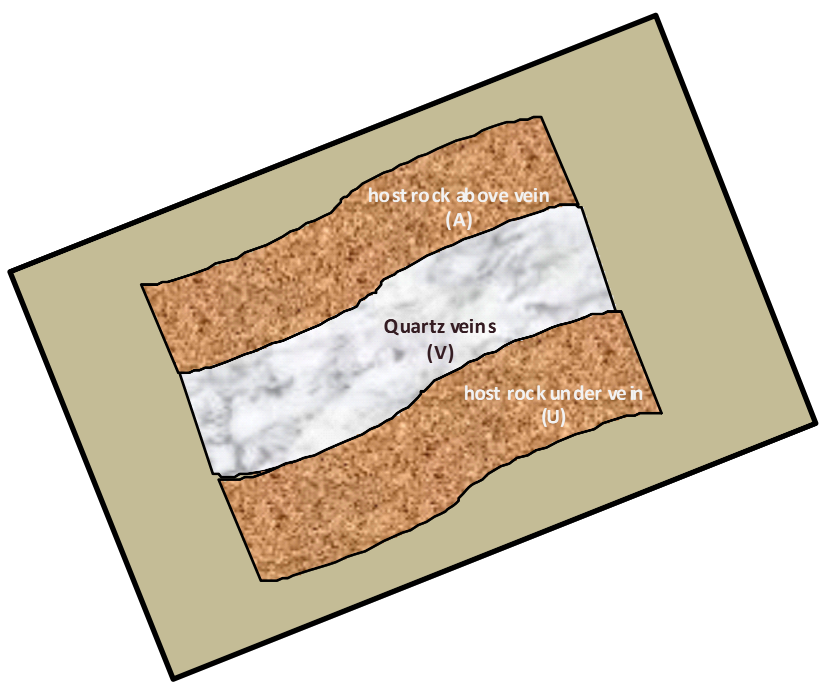

Figure 3. Illustration of Karang Paningal quartz vein within its dacitic-lava host rock (sketch without scale)

Thin section analyses also provide information regarding alteration intensity by calculating the percentage of altered minerals. The result shows that the alteration phase within dacitic lavas consists of primary, secondary and rare alteration minerals. The primary one is characterized by dominant minerals such as sericite, quartz, and chlorite while minerals within the secondary, represented by kaolin and carbonate minerals, vary in its existence and quantity. Rare alteration mineral is epidote. Referring to the dominant alteration minerals, the alteration in this area occurs as sericitization, silicification and argillitization.

Vein Structures

Simple quartz vein normally performs a consistent distribution pattern of a vein structure or its assemblages. The pattern may serve as a zoning model for fluids evolution in a geothermal boiling system for gold deposition. Thin section studies of specimens from veins, rocks above veins as well as rocks under veins determine the structure assemblages that are available within such specimens. Based on the studies, vein structures at Karang Paningal area are classified into chalcedony, vuggy and comb structures.

Chalcedony Structures

Veins with chalcedonic structures at Karang Paningal retain light brown to blackish brown in color. The texture is commonly aphanitic, wax luster and gains conchoidal fracture that means when they break, they do not follow any natural planes of separation. In some places, metal-bearing oxide minerals characterize the veins.

Chalcedonic structures belong to super zone of primary growth structure. It occurred at a condition of supersaturated hydrothermal solution with respect to quartz. Thin section analyses show that the structures are a fibrous variety of cryptocrystalline quartz, surrounded by fine quartz particles (Figure 4). Minerals that were commonly deposited within structure are chalcedony along with other quartz minerals (such as moganite) and pyrite. Those minerals are normally deposited at 100 to 190°C (low temperature). Nugraha (2001) suggested that the structures at Karang Paningal belonged to low sulfidation epithermal deposits and the deposits are normally deposited at 100 to 190°C (low temperature). The eroded level of this structure is very low as the chalcedony was deposited at the top of the zone.

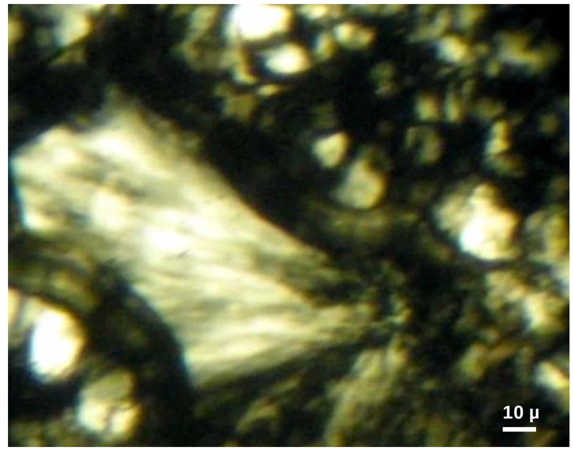

Figure 4. Chalcedonic structures found within one of quartz veins at the Karang Paningal gold mine

Vuggy Structures

Similar to chalcedonic structures, the vuggy structures are included within the super zone of primary growth structure and occurred at the condition of supersaturated hydrothermal solution with respect to quartz. Macroscopically, the veins with vuggy structure are milky white in color and retain aphanitic crystalline matrix and vitreous luster as well. Its vug diameter is commonly between 1 to 50 mm. The vuggies themselves are stuffed by very fine quartz that performs some open spaces. The spaces are then filled by oxide minerals such as limonite and hematite. Minerals surrounded vuggy structures are euhedral quartz and other minor minerals (Figure 5). Quartz within vuggy structures was then altered due to low pH fluids (normally 2). It took place at 200 to 250°C, gaining some alteration minerals such as quartz, adularia and oxide minerals. Referring to those facts, the Karang Paningal veins with vuggy structures are included within low sulfidation epithermal deposit that was deposited in the early epithermal process (Chen Yanjing et al., 2003).

Comb Structures

When minerals crystallize inward from opposite walls of a vein, they often meet in the center to form interdigitating pattern of crystals (usually quartz), which has an appearance similar to a rooster's comb. They grow perpendicular to vein

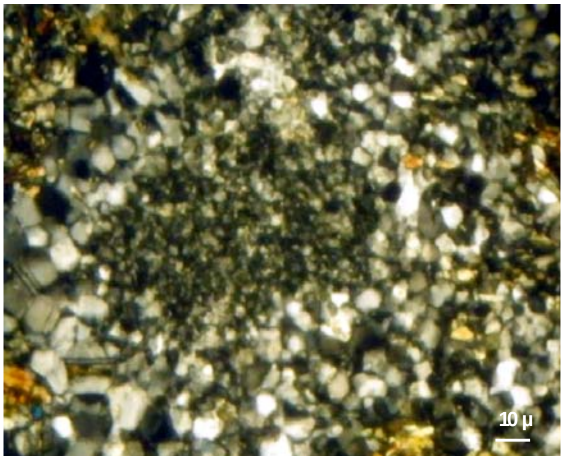

Figure 5. Vuggy structures found within Karang Paningal quartz veins performing aphanitic quartz-containing vug that is surrounded by euhedral and othe minor minerals

wall that indicate infilling of an open fracture. Its vein is normally transparent to milky white in color and contains subparallel quartz with massive fabric. Thin section analyses found that specimens taken from the vein wall indicated comb structure (Figure 6). Nugraha (2001) states that the combs resulted from supersaturated hydrothermal solution with respect to quartz but less saturated to chalcedony in an open space. This condition is enabled as the hydrothermal solution is subjected to slow cooling and produces uniform performance along the vein wall. Comb structure refers to low sulfidation epithermal deposit.

Epithermal Alteration

Karang Paningal area is characterized by two rock units, namely dacitic, volcanic breccias and the younger one, quartz veins, which intrude the former rock as shown in microscopic analyses of several thin sections (Figure 7). The veins are supposed to be developed from several joints within the breccias, filled by precious metal-containing hydrothermal solution. The solution produces a group of certain minerals known as mineral assemblages that show alteration type such as propylitic, sericitic, potassic, albitic, silicification, silication, carbonatization, alunitic, argillic zeolitic, serpentinization and talc alteration and oxidation as well. The alteration commonly occurs as a zoning. This phenomenon is similar to those occurs at Butte, Montana as shown in Figure 8. At this area, advanced argillic alteration characterizes proximal portions of the veins. The alteration is then superseded outwards by sericitic alteration, while the distal portions are characterized by propylitic alteration adjacent to the vein, which gives rise to fresh unaltered rock further away from the vein. The mineral assemblages found within veins include pyrite, sphalerite, galena and chalcopyrite that exhibit texture of banded, vuggy and comb. The veins perform NW-SE direction and are measured (maximum) 75 cm. Its features show en echelon structure (Figure 9) that is supposed to be came from hydrothermal-filled joints in a brecciation and kaolinization zones (www.dmtcalaska.org/course_dev/explogeo/class08/ notes08.html).

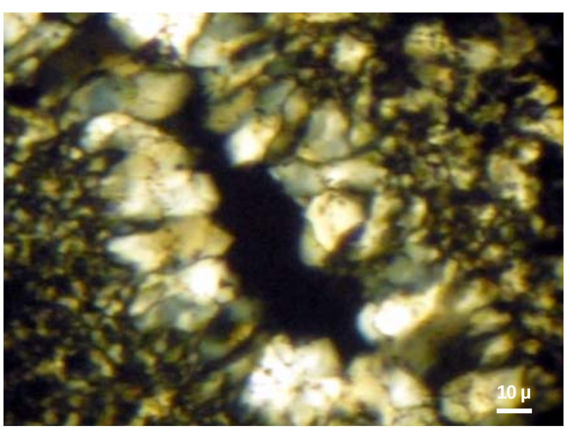

Figure 6. Comb structures found within Karang Paningal quartz veins were performed by quartz crystals

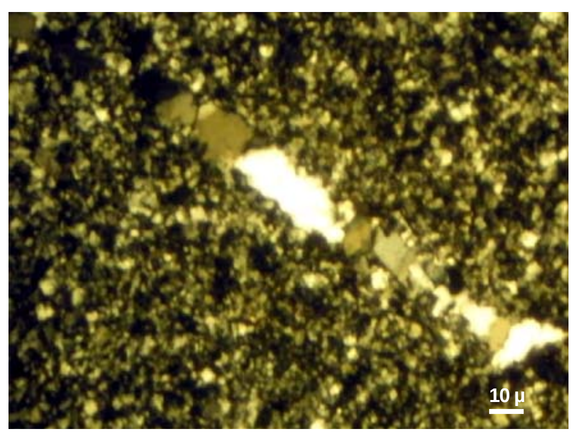

Figure 7. Karang Paningal quartz veins intruding dacitic, volcanic breccias

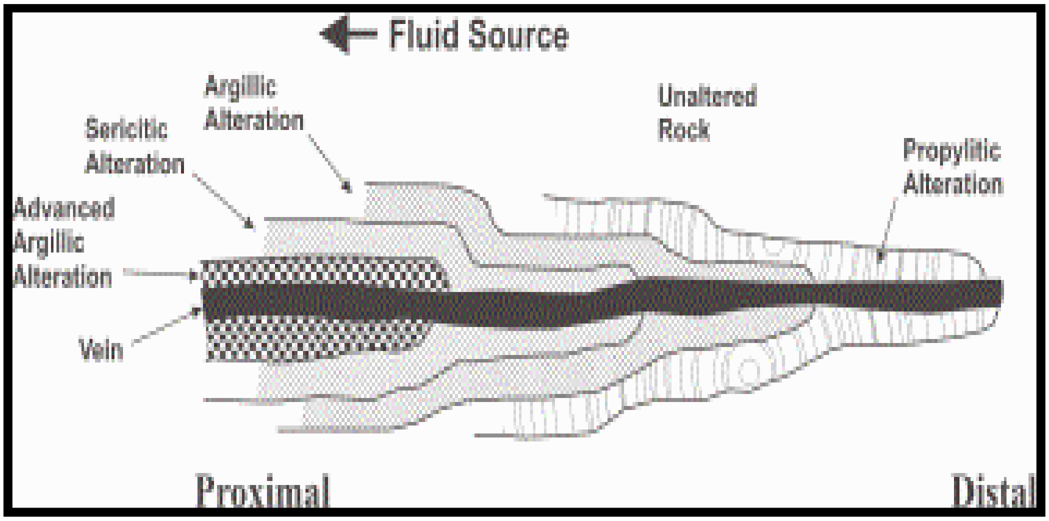

Figure 8. Alteration zoning due to hydrothermal process at Bute, Montana (modified from www.dmtcalaska.org/course_dev/explogeo/class08/notes08.html)

Figure 9. En echelon joints that are similar to those occurs on dacitic, volcanic breccias at Karang Paningal (source http://en.wikipedia.org/wiki/En_echelon_vein).

Normally, the alteration process at the site occurs in three zones, namely silicification, sericitization and argillization alterations. The former is characterized by the assemblage minerals of sericite-silica-carbonate minerals and strongly changes the rock-forming minerals available within dacitic, volcanic breccias. The second zone produces sericite-silica minerals. The process is also categorized as strong alteration. Clay mineral assemblages characterize the argillization zone. Its alteration minerals is mostly carbonaceous ones.

Country Rock Alteration

Based on the available alteration minerals, the altered rocks at Karang Paningal area are characterized by intermediate and strong altered rocks as well. The former is available in the northern part of the site and partly occurs to dacitic, volcanic breccias. The alteration process produces sericitic alteration that is dominantly characterized by sericite mineral along with ore minerals- mostly sulfides. Almost 25% of rock-forming mineral within this area underwent sericitic alteration. Of the 25% altered minerals, around 3 – 9% belong to the ore minerals performing banded structures and intergrowth performance with quartz and carbonate minerals.

The fact that the southern part of the site owns normal fault is the reason why the alteration in this part occurs strongly. The fault seems the medium for hydrothermal solution to come out and change the original mineral to the other ones. Almost all of rock forming minerals are altered into sericite, quartz and carbonate minerals. Disseminated pyrite and galena represent the type of mineralization within the site.

Vein Alteration

Commonly, hydrothermal alteration on the vein results in mineralization. Pressure, temperature and vein fractures are components that are responsible for hydrothermal breccias formation at the Karang Paningal area. The hydrothermal breccias are composed of host rock components cemented by fluids mineralization matrix. Based on its mineral intensity, the alteration processes within vein include those that result in chalcedonic texture and those that produce vuggy-comb texture. The former retains low intensity and is characterized by carbonate minerals while the later performs high intensity and represented by sericite and quartz as its main minerals.

The chalcedonic vein is supposed to come from hydrothermal fluids with low temperature and pressure. Low temperature insinuates that the veins occur at the end of hydrothermal processes as a result of mixing between hydrothermal fluids and meteoric water. Low alteration intensity at this area means that the hydrothermal fluids imperfectly react with the country rocks due to low pressure of the hydrothermal fluids. This results in imperfectly mixing of both components. The veins are then only dominated by quartz and chalcedony minerals. The abundant sericite in some area shows that the area belongs to high sulfidation system. It assumed that temperature formation is above 250°C (Anon., 2001; Al-Hwaiti et al, 2010).

Epithermal Mineralization

Epithermal deposits occur within about 1 km of the earth surface and fairly low temperature of 50 to 200°C (Anon., 2001; Al-Hwaiti et al, 2010). The deposits are typically hosting of Au, Ag and base metals and normally consist of opal, chalcedony, quartz, calcite, aragonite, barite and fluorite with a number of other gangue minerals as well as certain sulfides such as, cinnabar, stibnite and pyrite. Less common sulfides within the deposits are chalcopyrite, galena, sphalerite and arsenopyrite.

Fluids changes commonly characterize the epithermal environment. The changes can be seen by observing depth interval of metal mineralization zone, namely, base metal, noble metal and surface metal mineralization zones. Base metal mineralization is transported by complex chloride fluids and it occurs at the bottom bed. During the process, temperature and salinity decrease significantly (Corbett, 2001). Complex sulfide fluids that carry noble metal is affected by pH changes, water content and sulfide complexity itself, while sulfide or chloride complexes or combination of both are responsible for silver and copper mineralization. The later refers to transition zone of base metal and noble metals.

Sulfide Minerals

Of the whole rock-forming minerals quantities within Karang Paningal, less than 5% of them go to metal minerals. This indicates that such metal minerals retain low intensity. The metal minerals include pyrite, chalcopyrite, sphalerite and galena. Based on its paragenesis, the minerals are classified into:

- primary metal minerals. The minerals occur simultaneously or right after hydrothermal process and normally are characterized by pyrite and chalcopyrite. Pyrites take place on dacite porphyries in either intermediately altered or strongly altered rocks. The former is less than 5% of the whole rock-forming minerals, while the later is around 4 to 9% and performs spotted and disseminated characters with subhedral to anhedral shapes. The spotted pyrites commonly arrange fissure structures. Similar to pyrites, the chalcopyrites, around 1 – 2%, also occur in intermediately altered and strongly altered rocks;

- secondary metal minerals. Its occurrence takes place after hydrothermal process. Natural oxygen seems the medium to oxidize the pyrites. Its production fills the fissures within rocks to perform veinlets.

The alteration of native gold is commonly characterized by three elements, namely gold (Au), silver (Ag) and copper (Cu). As the native gold is normally a solid solution that composes of Au, Ag, Cu and other elements such as Pb and Zn, contents and ratios of the three elements could describe the alteration level in one area. To determine the contents of precious metals (Au, Ag) and base metals (Cu, Pb and Zn); samples were collected from veins, rocks above veins and rocks under veins as well surround Karang Paningal area. Around 15 samples were taken from the veins. Similar quantities were also sampled to rocks above veins and that of under veins respectively. All samples were then assayed to calculate the element contents. Results are shown in Figure 6. Of the five analyzed elements, silver exhibits the highest content in veins, rocks above and under veins; namely 23.91, 5.32 and 10.81 ppms respectively. Gold is the second one, followed by copper, lead and zinc. Gold content is high enough in the veins (12.12 ppm) but decreases to 6.17 ppm within rocks under veins and 3.11 ppm in the rocks above veins. This means that the enrichment occurs notably in the vein but the rocks above and under veins were enriched by residual hydrothermal solution that results in poor content of the elements (Al-Hwaiti et al, 2010; de Ronde, 2005).

Ag/Au ratio is considered to be the single most useful indicator of both gold potential and space-time changes in ore-forming environments; also, the focus on Ag:Au allows for comparison between the change in this variable in space and time in porphyry- related systems compared to epithermal precious metal deposits and active geothermal systems. The average contents of gold and silver within Karang Paningal vein is 12.26 and 23.91 ppms respectively (Figure 10). Such figures produces the Au/Ag ratio around 1:1.95 as shown in Table 1 and it means that Karang Paningal deposits belong to an epithermal system (Einaudi in www.pangea.stanford.edu/research/ODEX/marco-ag-au-bingham. html). The fact that the Au/Cu ratio of the vein is around 1:0.94 supports the idea that the Karang Paningal deposit occurs at low temperature (50 to 200°C) shallow depth, less than 1 km (Hedenquist et al, 2000). Table 1 also shows the Au/Ag ratios of rocks above and under veins, namely 1:1.71 and 1:1.75 respectively along with the Au/Cu and Ag/Cu ratios. Those figures approve such the idea that Karang Paningal deposit is an epithermal one that takes place at low temperature and shallow depth and the vein at this area seems the prospect one for gold exploitation.

Table 1. The ratios of Au/Ag, Au/Cu, and Ag/Cu in the Karang Paningal deposits

	Au : Ag	Au : Cu	Ag : Cu
vein	1 : 1.97	1 : 0.94	1 : 0.48
host rocks above veins	1 : 1.71	1 : 0.29	1 : 0.17
host rocks under veins	1 : 1.75	1 : 0.17	1 : 0.08

CONCLUSIONS

Microscopic analyses of thin and polished sections show that the epithermal vein at Karang Paningal is characterized by alteration minerals such as sericite and carbonate minerals featuring comb –vuggy textures as well as chalcedonic quartz. Such an alteration is divided into two groups, namely chalcedonic and vuggy vein alterations. The first one that occurs on the rocks above veins performs mostly carbonate minerals while the second one that takes place on the rocks under veins consists dominantly of sericite and quarts.

Chalcedonic vein is assumed to occur due to low temperature and pressure of the fluids. Low temperature insinuates that the vein takes place at the final stage of hydrothermal stage as a result of mixing between hydrothermal fluids and high-con-

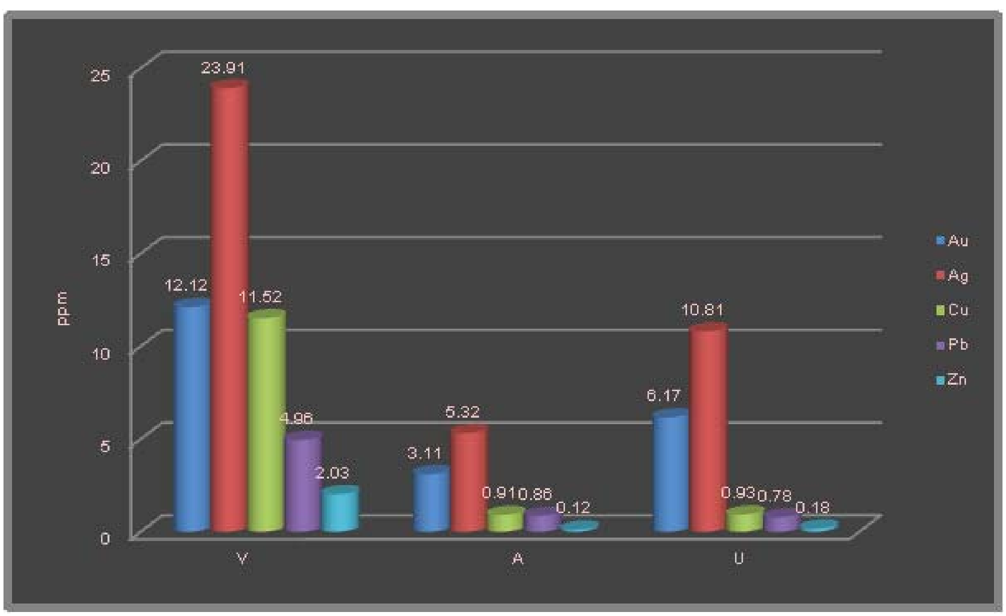

Figure 10. Contents of precious (Au, Ag) and base metals (Cu, Pb, Zn) available within the vein (V), rocks above (A) and under veins (U) at the Karang Paningal area.

tent meteoric water. The former produces vuggy-comb texture while the later yields chalcedonic one.

Vein with gold content of 12.12 ppm and silver of 23.91ppm seems the most prospective part to be exploited by small scale miners, followed by the lower host rocks (rocks under veins) that perform Au and Ag contents of 6.17 and 10.81 ppms respectively. Though it only retains 3.11 and 5.32 ppms of gold and silver contents, the upper host rocks (rocks above veins) is relatively feasible to be employed by such miners.

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