Introduction

Java Island is part of the Sunda Banda magmatic arc which extends from Ache in the west to Banda in the south (Carlile & Mitchell, 1994). This arc is well known as a host for several hydrothermal gold-copper deposits, such as Martabe high sulfidation deposit in North Sumatera; Lebong Tandai gold mine in Bengkulu; Way Linggo gold mine in Lampung; Cibalangi gold mine in Banten (Harjoko, et al 2010); Gunung Pongkor gold Mine in Bogor; Tumpang pitu gold-copper deposit in Banyuwangi; and the Gold-copper porphyry deposit at Batu Hijau, Lombok.

Physiographically, the southern part of Java Island belongs to the Southern Mountain Zone (Bemmelen, 1949). These area is covered by volcanic products mainly of Oligocene to Pliocene age, which were affected by hydrothermal activity. Several epithermal gold prospects occur within this zone. these include Papandayan prospect in Garut(Yuningsih et al, 2010), Cineam prospect in Tasikmalaya (Widi & Matsueda, 1998), Kaputusan prospect in Pacitan, Tujuh bukit prospect in Banyuwangi.

The Tanggeung gold prospect is located about 50 km from Cianjur, or about 120 km southeast of Capital City Jakarta (Fig.1). The prospect lies within the Southern Mountain Zone, where several hydrothermal gold deposits are located. The area is mainly covered by Late Miocene sandstone and claystone of Koleberes Formation, and overlain by Pleistocene-Pliocene pyroclastic tuff. Koleberes Formation was intruded by Late Pliocene hornblende andesite (Koesmono et al, 1996). The lineament trending NW-SE and circular features are interpreted from the combination of Landsat TM and SRTM imagery (Sunarie et al, 2010).

This study is to identify the characteristics of gold bearing quartz veins, especially alteration, mineralization and fluid inclusions.

Methodology

In an attempt to understand the mineralization, alteration and fluid conditions several methodologies were applied during the study, these are grouped into 3 methods:

- Fieldwork:
Field geology and alteration-mineralization mapping.
- Samples collection
- Laboratory analysis:
  - Petrography, mineragraphy, XRD, Fluid inclusion, AAS
- Evaluation and reporting:
  - Landsat interpretation
  - 3D topography
  - Alteration and mineralization map
  - Model mineralization

These methodologies mentioned above are expected to be able to elucidate gold mineralization in the study area. Furthermore, results of the study can determine mineralization type and hereinafter, estimation of the present condition by study of paleo-isotemperature drawn from alteration mineralogy mapping in order to identify the fluid discharge zone.

Results and Discussion

Geology

The study area is mainly covered by sandstone and partly by mudstone of Keleberes Formation of Late Miocene age. The central part of the study area is covered by tuff and lapilli tuff as part of Volcanic Rock Formations of Pleistocene-Pliocene age. The volcanic breccias are locally found in several areas. Hornblende andesites are locally distributed, as lava and hypabyssal intrusions which is indicator of the magmatic signature (Fig 2).

Sedimentary rock was utilized to recover strike and dip data which predominantly oriented in a northeast to southwest direction. In the southeastern part of the study area, the strike/dip data indicates anticlinal folding as shown on figure 2.

![Geological map of Tanggeung prospect](image)

The strike/dip data in the central part of mineralization area indicates it has been deformed and affected by strike slip faulting. At least one sinistral fault and two dextral faults were found in this area. These strike slip faults are estimated as a control for the fluid mineralization direction, mainly for Cilangkap, Cicelak, Cigadobras and Honey hole mineralized veins.

The host rock for gold bearing quartz veins in the Tanggeung area are mainly Pliocene-Pleistocene volcanic rock formations, although an alteration zone is found in sedimentary formations periphery to this mineralization. The trend of mineralization is NW-SE following strike-slip faulting. The geological structures of the area are affected by NW-SE dextral strike slip faults in accordance with the strike/dip data of sedimentary rocks.

Alteration
More than 170 samples were collected from the field area which were analyzed by the X-ray diffraction (XRD) method. The mineral alteration can be identified as illite, smectite, silicification, mixed-layer chlorite-epidote and illite-smectite (Fig.3). The illite zone regarded as the center of mineralized area where most of the discovery quartz veins are located.

![Figure 3. The distribution of minerals alteration of Tanggeung prospect based on the XRD analysis result](image)

It is interpreted as the center of mineralization in the Tanggeung area like shown in figure 4. The large of the centre zone is about 3.1 km x 4.5 km. The gold bearing quartz vein and hydrothermal breccias lie within the illite zone such as Cicelak, Honey hole, Cigadobras, Cilangkap and Cicengal. The illite zone in the eastern part which closed to Cigadobras vein must also be considered as another prospect of mineralization. There is the potential that prospective mineralization here may be covered by soil. Silicification can be found as wall rock of mineralized quartz veins which is indicative of as fluid conduit.

![Figure 4. Gold bearing quartz veins within the illite zone of Tanggeung prospect](image)

**Mineralization**

Nine zones of mineralization are identified during field mapping. All zones are hosted by tuff. The mineralized zone occurrences are classified into vein type and hydrothermal breccias. The vein type named as Cicelak type, consists of six gold bearing quartz veins, they are; Cicelak, Cigadobras, Pasir Bedil, Cilangkap, Honey hole and ST-7 veins. While the hydrothermal breccia type, named as Cicengal type, consists of; Cicengal A and B and Cibogo hydrothermal breccias (Fig.5).

Most of the veins are trending in a N330°E to N350°E direction and dipping 70°-80° towards to east. The vein thickness ranges from 4 to 15 centimeters. The mineralized quartz textures have been determined in an effort to figure out the mineralization type based on their characteristics. Generally they have vuggy, saccharoidal, massive and comb textures. Colloform banding texture is also found in Cicelak and ST-7 veins. A medium grain size crystalline texture exhibited in Cilangkap, Honey hole and Pasir bedil veins (Fig.6). Whereas fine crystalline texture was observe in Cigadobras vein.
The main ore minerals identified within the quartz vein or hydrothermal breccias are mainly pyrite associated with chalcopyrite, sphalerite and galena. The gangue minerals are mostly quartz, illite, kaolinite, sericite and smectite. No carbonate minerals are observed in the vein. In microscopic observation, pyrite and chalcopyrite are mostly found in all quartz veins. Sphalerite is found in Cicelak vein, Pasir bedil vein, Citangkap vein and Cibogo vein. Galena is found in Cicelak vein and Pasir bedil vein. Oxidized copper as chalcocite and covellite were observed in Citangkap vein. ST-7 vein and Cicengal vein (Fig.7).

The metal content in each vein is varies and some of them have high gold and base metal contents. Geochemical analysis shows significant content of gold and silver in Celak, Cicengal-B, Citangkap, Honey hole, Cigadebas and Pasir bedil veins, while other base metals of Cu, Pb, Zn are also present in Celak, Honey hole and Citangkap veins. Metal content in the quartz veins are varies from 0.13 to 82.33 g/t Au, 2 to 79 g/t Ag, 46 to 5370 g/t Cu, 15 to 10580 g/t Pb and 11 to 40820 g/t Zn. The general characteristics of quartz veins are summarized in Table 1.

| Table 1 | General characteristics and geochemistry result of the gold bearing quartz vein from Tanggeung prospect.

Fluid Inclusion

Fluid inclusion studies were conducted from
inclusions trapped in quartz. An extensive microthermometric study of mineralized quartz veins in the Tanggeung area has been done for 6 representative samples. Primary inclusions mostly occur as bi-phase, liquid-vapour (Fig.8).

Figure 8. Fluid inclusions from Pasir bedil quartz vein (left) and from Cilangkap vein (right).

Homogenization temperature of fluid inclusions from Cilangkap vein has an average of 279°C with a salinity of 0.57 NaCl eqv wt %. Cicelak inclusion exhibit a lower temperature, at about 255°C and salinity 1.2 NaCl eqv wt %. Inclusions from Honey hole indicate an average homogenization temperature is 268°C and a salinity of 2.70 NaCl eqv wt %.

Cigdebras inclusions indicate a homogenization temperature at 264°C and a salinity of 2.25 NaCl eqv wt %. However the Cibogo and Cicengal indicate a temperature higher in comparison to other quartz veins. The homogenization temperature for both veins is 291°C and 319°C, with a salinity 8.41 NaCl eqv wt %, and 10.43 NaCl eqv wt %, respectively (Fig. 9 and Fig.10). Based on the above data, it is clear that the Cicengal mineralization type (gold bearing hydrothermal breccia type) indicates a higher temperature and salinity in comparison to the Cicelak type (gold bearing quartz vein type) as shown in figure 11.

Based on the vein texture characteristics, ore mineral associations and fluid inclusion studies, it is interpreted that the mineralization in Tanggeung prospect is classified as epithermal low sulfidation type. The fluid temperatures, salinity, vein texture and ore mineral assemblages shows that the mineralization in Tanggeung prospect occurred in two forms, quartz vein (Cicelak type) and hydrothermal breccias (Cicengal type). The fluid inclusion study also confirmed that Cicengal type is formed in a more deeper part of the system in compared to Cicelak type.

Figure 9. Homogenization temperature and salinity of fluid inclusions from Cicengal vein.

Figure 10. Homogenization temperature and salinity of fluid inclusions from Cigdebras vein.

Figure 11. Relationship between homogenization temperature and salinity of gold bering quartz veins and hydrothermal breccia vein.
Exploration Implication

Landsat studies, based on Landsat TM, combining band 4-5-7 has been performed to identify the lineament features in Tanggeung and surrounding area. Structural lineaments and circular features at Tanggeung region shows that lineaments are trending NW-SE relatively. These trends are coincident with the veins trend at Tanggeung area, measured using strike/dip.

The Tanggeung gold prospect is located on the edge of circular features and associated with a volcanic intrusion (Fig.12). For further exploration, it required that more attention is paid to the extension of the Cicelak vein, as it shows a lineament extension for about 1 km to the south. Furthermore, a similar lineament also observe to the south of the Cilandkap vein and the Honey hole vein. This prediction can proved through a detailed exploration program in the area, especially to the southern part of boundary area. Where Cilandkap and Honey hole veins occur along similar trend of the lineament features (Fig.13). This study gives clues ok for other prospects along the area where the circular drepresion are cross cut by lineament features.

Figure 12. The lineament geological structures from landsat study, and the location of quartz veins in Tanggeung prospect.

Figure 13. The illite zone and lineament geological structure from landsat study, and the location of quartz veins in Tanggeung prospect.

Conclusion

The gold bearing quartz veins in Tanggeung prospect are trending mostly NW-SE and hosted by mainly tuff of Pleistocene-Pliocene ages. The mineralized quartz veins exhibit fine-medium crystalline, vuggy, saccharoidal, colloform banding and massive textures. The mineralized zone occurrences are classified into vein type and hydrothermal breccias. The Cicelak type vein consists of six mineralized quartz veins, they are
Cicelak, Cigadobras, Pasir Bedil, Cilangkap, honey hole and ST-7 veins. While the hydrothermal breccias type (Cicengal type) consists of Cicengal and Cibogo hydrothermal breccias.

The illite-smectite zone and chlorite-epidote zone have limited distribution outward of the illite zone. The mineralized gold bearing quartz veins occur within the illite zone for about 3.1 km x 4.5 km.

The ore minerals consist of chalcopyrite, pyrite, sphalerite, galena and oxide minerals such covellite, chalcocite and hematite. The gangue minerals are mainly quartz and some clay minerals.

Based on fluid inclusion studies Cicelak type exhibits a homogenization temperature range of between 260° to 278° C and a salinity from 0.57 to 2.7 NaCl eqv wt %. While the Cicengal type indicates a homogenization temperature range of between 291° to 319° C and salinity from 8.4 to 10.4 NaCl eqv wt % respectively.

The characteristics of both Cicelak and Cicengal type indicates typical epithermal low sulfidation type. Although the fluid temperatures and salinity shows that the Cicengal type is formed in more deeper part of the system in comparison to Cicelak type.

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References


