Available online at: http://proceeding.rsfpress.com/index.php/ess/index
LPPM UPN "Veteran" Yogyakarta Conference Series
Proceeding on Engineering and Science Series (ESS)
Volume 1 Number 1 (2020): 1-11

The Hydrothermal Breccias Characteristics of The Tumpangpitu Porphyry Cu-Au-High Sulphidation Epithermal Au Prospect, Banyuwangi, East Java, Indonesia

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Abstract

The research area is administratively located in the Tumpang Pitu Pit Site, Sumberagung Village, Pesanggaran District, Banyuwangi Regency, East Java Province which is included in the coordinate system of the Universal Transfer Mercator (UTM) WGS 84 zone 50S. Compared with phreatomagmatic activity, which is caused by interaction / direct contact between the body of magma and water, phreatic activity releases less energy, and consequently smaller phreatic breccia dimensions. Phreatic breccia or hydrothermal breccias are quite often misinterpreted as phreatomagmatic structures. Hydrothermal breccias are formed in the hydrothermal system, generally at a depth of 200-300 m, and rarely at a depth of 500-1000 m. Based on geological structure analysis, it can be seen on the structure pattern map in the Tumpang Pitu area, there are 2 major faults in the Northwest - Southeast direction. These 2 major faults are the main controller for the formation of minor faults in the Tumpang Pitu area. There is a structural pattern that develops between these 2 major faults, which is a "metallogentically fertile structure" fault or in this pattern mineralization occurs. Based on field observations, core drilling, ASD analysis, and petrographic analysis, the type of alteration based on the mineral assemblage is divided into five, they are quartz, quartz-alunite, quartz kaolinite, kaolinite-montmorillonite-chlorite, and kaolinite-montmorillonite alteration. Mineralization rocks in the study area are volcanic and volcanic clastic rocks and occur as vuggy replacements and stockworks, disseminated, fractures, and veins. Hydrothermal breccias in the Tumpang Pitu area are characterized by enrichment zones of the hydrothermal system with an abundance of sulfides (Goetite, Hematite and Limonite), with Jigsaw and Crackle breccia textures, the mass in the form of sulfide minerals Goetite, Limonite, Hematite, 50-90% silica content and weak to strong vuggy texture. Veins and veinlet that develop are Sugary quartz - sulphide veins (chalcopyrite, bornite) (A Type), sulphide-center line crystalline veins (B Type), pyrite + quartz-chalcopyrite veins (D Type), early biotite (EB Type), High sulfidation epithermal veins (pyrite-bornite-chalcocite-covellite-tetrahedrite-tennatite-enargite) (HSE type), and Magnetite veins (M Type). Assuming homogenisation temperature is identical to formation temperature, the Tumpang Pitu epithermal gold deposit HS is formed at the intermediate temperature 270◦C and 310◦C. The average melting temperature is -0.3◦C and -0.7◦C which correspond to the salinity of hydrothermal fluid of 0.5 to 2% by weight equivalent to NaCl. Paleo depths from shallow and deep samples taken were around 650m and 1220m

Keywords: Hydrothermal Breccias, Alteration-Mineralization, Porphyry , H.S. Epithermal Au

I. INTRODUCTION

Tumpang Pitu area is one of several mineral prospects of Tujuh Bukit Project, located in the south east portion of the Project area. Tujuh Bukit Project area covers 11,621 hectares under mining exploration title "IUP" the form of exploration/ mining title introduced under the new Mining Act. Intrepid, through a joint venture agreement with Indonesian title holder, PT Indo Multi Niaga. Tumpang Pitu prospect is administratively located at Sumber Gandeng village, Pasanggaran district, Banyuwangi regency, East Java Province, Indonesia. This location is reachable with four wheel or two wheel vehicle, about 58 km to the southwest from Banyuwangi city, or approximately 205 km south-east of Surabaya, capital of the Province of East Java

Mineralisation type of Tumpang Pitu prospect was interpreted as high sulphidation Au-Ag±Cu zone overlying and partially overprinting a porphyry Cu-Au-Mo system. In addition to its continued development of both high sulphidation resource and the extensive deeper sulphide porphyry system within the Tumpangpitu prospect, Intrepid has recently started exploration activities on a number of newly discovered areas.

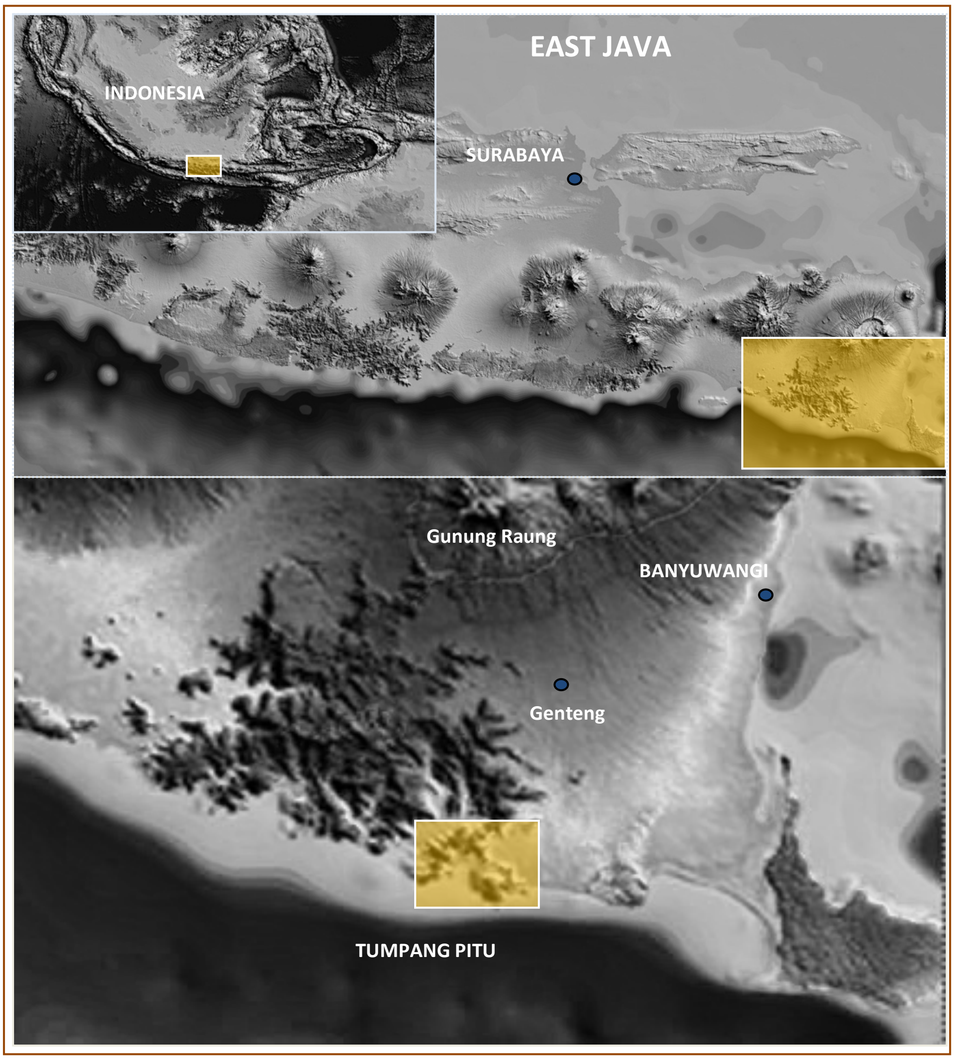

Figure 1. Location map of the Tumpang Pitu area.

Physiographically, the Tumpang Pitu area and its vinicity is a part of the East Java Southern Mountain Zone, mostly occupied by both plutonic and volcanic igneous rocks, volcanic clastic rocks, silisic clastic rocks and also carbonate rocks. Magmatism at this area is represented by existence of lava basalt, basaltic andesite and andesite of Merubetiri Formation and Sukamade Formation, and granodiorite-adamelite that intrude the older rocks of Merunetiri Formation, Sukamade Formation, and Batuampar Formation. Magmatism processes of igneous rocks on Merubetiri area and its vinicity is begun in Early Oligocene. All of lavas of Merubetiri Formation have a tholeitic affinity. It means that Early Oligocene's magmatism-volcanism activity was still relatively young. Volcanic arc of magmatism of Miocene than move to the northward. Most volcanic rocks of Mandiku Formation are a product of Miocene magmatism, mostly have a calc-alcaline affinity.

Rock suites at this hill are particularly at middle part of the area has been altered to be advanced argillic alteration zone (dickite ± pyrophyllite ± alunite ± halloysite) and also got many vuggy silica. While at the east slope part has been altered to be argillic zone (dickite ± monmorillonite ± halloysite ± paragonite). In several outcrops are seen quartz vein stockworks that filled by iron oxide minerals (formed boxworks). Ore mineralization is mostly found inform at hydrothermal breccia. Wall rocks including diorite, dacite porphyry and tuff-breccia are also mineralized. Core drilling minerals shows the presence of chalcopyirite-sphalerite-covellite mineral assemblages which are usually found near the surface (<300m). While in depth of about 300-600 m, displays the occurrence of magnetite-chalchocite vein-stockwork system, which suggest the presence of possible of porphyry system. Gossan deposits (hematite±goetite) with many boxworks is found at Merah island, is extended to 50 x 100 m, located in offshore of about 250 m south of the Tumpang Pitu hill complex. Prophylitic alteration zone is identified in the rivers at westside of the Tumpang Pitu hill. The alteration zone is characterized by the presence of chlorite ± epidote ± quartz ± calcite assemblages, replacing primary minerals such as pyroxenes, plagioclases, and volcanic glasses of andesite rocks.

Most of hydrothermal deposit type recognized in Java arc are epithermal systems. Epithermal mineralization in West Java lie within and on flanks of Bayah Dome. Two noticeably different style of adularia-sericite epithetmal gold deposits are found in the Bayah Dome, they are reffered as Pongkor and Cirotan types (Marcoux and Milesi, 1994). The Cirotan type deposits are characterized by the abundant of sulphides, include Cirotan, Cikotok and Cikidang prospects, while the Pongkor types have very low shulphide content, include Pongkor and Ciawitali prospects (Marcoux and Milesi, 1994).

Several styles of mineralization include porphyry Cu-Au, epithermal Au including low- and high-sulfidation, carbonate base metal epithermal Au, quartz-sulfide Au, and volcanogenic exhalative Mn have been recognized in some parts of Central Java and the Autonomous Region of Yogyakarta (Sukmmandaru et.al. 2005). Porphyry Cu-Au deposit type, is only discovered in Selogiri, Wonogiri (Imai et al.,2009).

Low sulphidation epithermal, polimetallic veins, skarn type, and porphyry type have been identified widespread in the Southern Mountain of East Java. The Tumpang Pitu Prospect is the first deposit identified as porphyry system, in the east part of Java. Detailed scientific study on this deposit is still limited. Therefore this research will focus on detailed petrology, rock geochemistry and mineral geochemistry of hydrothermal diacnostic minerals as well as study on hydrothermal fluid evolution by mean of fluid inclusion analysis.

II. LITERATURE REVIEW

Magmatic arc of Java is part of Sunda-Banda arc, extendening from Sumatra trough Java to east of Damar Island, known has many ore deposits (van Leeuwen, 1994; Charlile and Mitchell, 1994). The arc is the longest arc in Indonesia, developed by northwards subduction of the Indian-Australian Oceanic Plate beneath the southeastern margin of Eurasian continental plate, named the Sundaland (Hamilton, 1979, Katili, 1989). The Tertiary magmatism on Java could be divided into two periods, i.e. the Late Eocene – Early Miocene magmatism and the Late Miocene-Pleiocene magmatism (Soeria-atmadja, et. al. 1991). The volcanic rocks of Late Eocene – Early Miocene magmatism are widespread at alongside southern part of Java, which usually has tholeitic affinity, while the Late Miocene-Peliocene magmatism has Calc Alkaline-High K Calc Alkaline series, distributed mostly on the northward from the Late Eocene – Early Miocene magmatism (Soeria-atmadja, et. al. , 1991; Figure 2). The eldest igneous rock of the Tertiary magmatic arch of Java is found at Pacitan area, East Java has showed age of about 42,73 ±9,87 m.a. This sample was taken from tholeitic lava andesite of Besole Formation (Soeria-atmadja et al, 1994; Sutanto et al, 1994). The Oligocene-Miocene intrusions and volcanic rocks are distributed abundant from East Java to West Java, while the distribution of the Mio-Pliocene intrusions and volcanic rocks in East Java are mostly covered by overlying Quaternary volcanic rocks (Figure 2; Gafoer and Samodra, 1993; Ratman et al., 1998).

The Magmatism activity at Tumpang Pitu and its vicinity complex is very interesting, due to the present of granitoid stock, are known as “Granite Mrawan" has age the Middle Miocene (van Bemmelen, 1949). There were found at least five type igneous rocks at the Tumpang Pitu-Merubetiri and vicinity, i.e. basalt, andesite,basaltic-andecite, dacite, and granodiorite. These igneous assemblages showing tholeitic-calc alkaline affinity (Eko Teguh and Sutarto, 2006).

The Tumpang Pitu prospect is is located near the southest of a~50 km-wide annular zone of strongly dissected topography that is interpreted to represent the relics of a former andesitic statovolcanic centre in East Java (Hellman, 2010). Regional stratigraphy of the east part of The East Java Southern Mountains (Jember-Banyuwangi and its vicinity), based on the 1: 100.000 Geological Map of Jember Quadrangle (Sapei et al.,1993) and the 1: 100.000 Geological Map of Blambangan Quadrangle (Achdan, A. and Bachri, S., 1993) , successively from the oldest are Merubetiri Formation, Sukamade Formation, Batuampar Formation, granit-granodiorit-micro diorit-dasit intrusions, Puger Formation, Kalibaru Formation, Quartenary volcanic clastic units, and Alluvial deposits.

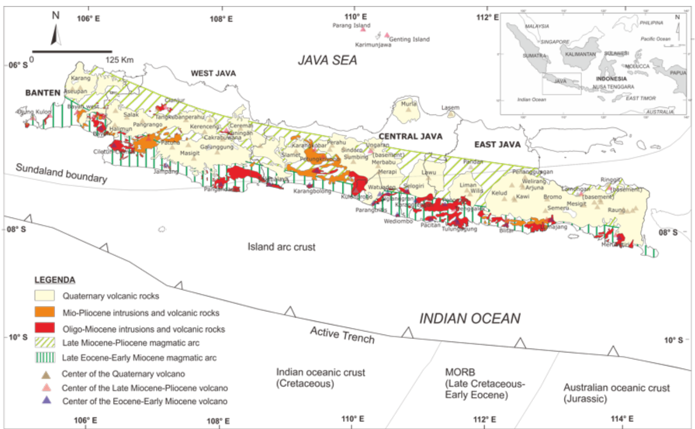

Figure 2. The distribution of the Tertiary magmatic arcs, Tertiary volcanic rocks and intrusions, center of the Cenozoic volcanos as well as basement crust types of Java island. The distribution of Tertiary-Quaternary volcanic rocks and intrusions is from the Geological Map of Indonesia Scale 1:1.000.000 Jakarta Sheet (Gafoer and Samodra, 1993) and Surabaya Sheet (Ratman et al., 1998), basement crusts is from Setijadji et al. (2006) and Setijadji and Maryono (2012). Tertiary magmatic arcs is from Soeria-Atmadja et al. (1994) while the distribution of Tertary volcanic center is compiled from Setijadji et al. (2006), Hartono and Bronto (2007), Bronto et al. (2008) and Abdissalam et al. (2009) (Sutarto et al., 2015).

The Lower part of Merubetiri Formation is compiled by intercalation of volcanic berccias, lava andesites, and tuffs. While in upper part consist of limestones intercalated by marls and calcareous tuffs. Merubetiri Formation is estimated aged Late Oligocene-Early Middle Miocene. Sukamade Formation comprise intercalation of sandstones and claystones, as product of turbidity processes. Age of Sukamade Formation is about Early Miocene-Middle Miocene. Batuampar Formation comprises a volcanic sandstones and volcanic breccia intercalated by conglomerates, tuff, claystones, and limestone is estimated aged Early Miocene-Middle Miocene. At the Tumpang Pitu area, most of these rocks were being strongly altered, and as host rocks of hydrothermal alteration-mineralisation of the Tumpang Pitu prospect and the Salakan prospect as well as . Stratigraphic contact between the Merubetiri Formation, Sukamade Formation, and Batuampar is interfengering. Many intrusive rocks were found widespread at the Tumpang Pitu area and the vicinity, comprising granodiorite, dacite, andesite, microdiorite. These intrusive rocks are about Midlle Miocene age and intrude the Batuampar Formation, Merubetiri Formation, and Sukamade Formation.

The Kalibaru Formation comprises a Quartenary volcaniclastic rocks, such as volcanic breccia, tuff, aglomerat, and tuffaceous sandstone. The unit rocks appear to represent part of the volcanic product that is largely derived from Raung Volcano to the north. In the Tumpang Pitu area and the vicinity, these volcanic rocks lie on the Tertiary volcanic rock of the Batuampar Formation. Puger Formation is dominated by Middle Miocene-Late Miocene coral reef limestones. Overlaying Puger Formation is Late Miocene volcanic rocks of Mandiku Formation. Both Puger Formation and Mandiku Formation have unconformity stratigraphic contact with underlying rock units of Merubetiri Formation, Sukamade Formation, and Batuampar Formation. In the north-east part, the most of Tertiary rocks are covered by the Quartenary volcanic clastic rocks of Raung volcano, Argopura volcano, and Ijen volcano. Based on the regional geology map (Blambangan and Jember quadrangle, Fig.3), trend direction of the mmajor structures, dominated by the NW-SE trending, and NE-SW trending, although N-S trending also found at the Tumpangpitu area. At the Tumpangpitu area, Cu-Au mineralisation prospect, also follow the structural trend, especially NW-SE structural trending.

III. RESEARCH METHODOLOGY

This research will be focused on the petrographic and mineral chemistry investigation of the pre-mineralization andesitic rocks and all syn-mineralization volcanic rocks, both laterally and vertically through of the Tumpang Pitu deposit. Therefore, the methodological approach of the research is as follows:

1. investigate distribution of igneous rocks on a regional and mine scale, map out contact (relative age) relationships, and collect a representative suite of sample of all types of pre- and syn-mineralization intrusions,

2. Petrography and Ore Mineragraphy analysis. Petrography analysis using thin section preparation will help to identify primary (rock forming minerals) and secondary minerals that formed by hydrothermal alteration as well as rock textures. This analysis will help to describe the kind of rock type and also the alteration hydrothermal type. Whereas mineragraphy analysis using polished section preparation is to identify opaque minerals (ore minerals), their textures and occurences.
3. X-Ray Diffraction (XRD) analysis to identify micro seconday minerals, especially to differentiate clay minerals. This analysis will conducted at Department of Geology UGM Yogyakarta, Indonesia.
4. Fluid inclusion is one of inclusions trapping in body a mineral in form as fluid (liquid and vapor) and sometimes contain crystal (solid) in surface temperature. Fluid inclusion analysis can provide information about the conditions existing during the formation of the enclosing mineral, such as temperature, pressure, and hydrothermal fluid compositions. The selected samples will be analysed using Linkham THSME 600 freezing and heating stage, Department of Mineralogy and Economic Geology, RWTH Aachen, Germany.
5. Major elements analysis use XRF (X-Ray Fluorecense) instrumens, while trace elements and rare earth elements (REE) analysis by mean of ICP-MS, Geochemistry Laboratory, Department of Mineralogy and Economic Geology, RWTH Aachen, Germany. With the Major elements, trace elements and rare earth elements (REE) datas, we can to know the evolution of magmas and the evolution of hydrothermal fluis as well as its tectonic setting.

IV. GEOLOGY AND HYDROTHERMAL BRECCIAS

Geology

There are many type rocks found at the Tumpangpiitu mount, such as volcanic sandstones, volcanic mudstones, tuffs, siltstones, volcanic breccias and andesitic lavas and many igneous intrusive rocks such as diorites, andesites, tonalites. Most of the rocks have been strong altered, caused primary rock forming minerals (feldspars, hornblendes, pyroxens), were replaced by secondary minerals (chlorites, carbonates, quartzs, hematites)

Lithology datas from outcrops and local mining at the Gunung Manis area, area predominantly volcanic sandstone, tuff, volcanic breccia, andesite, diorite, dasite and granodiorite. But, it's difficult to found the contact and stratigraphy relationship between those of rocks. Granodiorite is possibility younger than other rocks, both volcano clastic rocks or coheren lava andesites or basalts. In the valley or river channel, most the suh rocks usually covered by alluvial deposits. Most of the altered rocks of Gunung Manis and the alluvial deposits, usulally contain a gold mineralization, associated with the present of quartz-sulphide veins dan lack of carbonate veins (1-4 cm of thick). Chlorites, silicas, clay minerals are the commonly secondary mineral found at this area, associated with sulphide minerals especially chalcopyrites and pyrites.

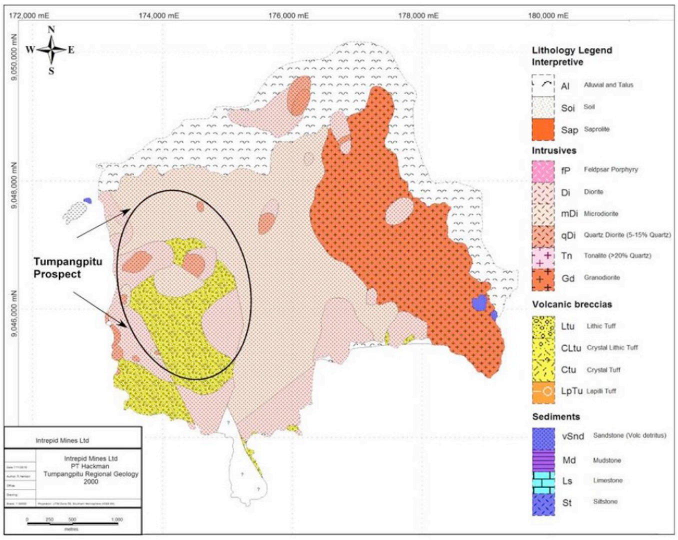

Figure 3. Lithology of the Tumpangpitu prospect area was mapped by PT. Hakman (1999). Hellman (2010)

Hidrothermal Alteration and Mineralization

Many experts have been reported about a magmatic related hydrothermal alteration at Tumpang Pitu area. Setijadji, et.al., (2006) reported that silica-clay (phyllic) alterations are found widespread along the beach of Tumpang Pitu and at an exposed diorite stockwork narrow quartz-pyrite-copper oxides veinlets are well developed. Mineralisation type of the Tumpang Pitu prospect was interpreted as a high sulphidation Au-Ag±Cu zone overlying and partially overprinting a porphyry Cu-Au-Mo system. The mineralizing system associated with the deep magnetic tonalite intrusion, that intruded into an older intrusion rocks, i.e. diorite and micro diorite stock.

Hellman (2010) reported that the Tumpangpitu prospect in the shallow epithermal environment is dominated by intense hydrothermally altered (silica-clay-alunite-pyrite) andesitic lithic volcanic breccias, diatreme breccias, hydrothermal breecias and diorite, with the alteration footprint covering an area in excess of 4 km x 2.5 km. The broader envelope of argillic altered volcanics and intrusives are cross-cut by several northwest-trending and potentially structurally-controlled zones of hydrothermal breccias which are advanced argillic altered (vuggy silica, silica-alunite, silica-alunite-clay, silica-clay-alunite and silica-clay). While the deeper portions of the Tumpangpitu prospect is characterized by alteration and vein assemblages characteristic of porphyry systems. The Porphyry Cu-Au-Mo mineralization occurs within a shell of magnetite, quartzmagnetite and quartz vein stockwork that occurs within and around the periphery of the causative tonalite intrusion, overprinting both the outer margins of the intrusion as well as the proximal country rock. This mineralization occurs dominantly within areas characterized by phyllic overprint of potassic alteration and lesser areas of potassic alteration within the tonalite intrusion. There are many mineralisation Cu-Au prospect block on the Tumpangpitu area, such as Tumpangpitu Mount Block, Gunung Manis-Katak Block, and Gumuk Gendruwo-Lompongan Hill Block.

Most the rocks at the Tumpangpitu hill are have been strong hydrothermaly altered. Alterasi and mineralization hydrothermal indication widespread found at this area. Based on the present of the altered minerals, the Tumpangpitu area can devide to three alteration zones alterasi that is argillic zone a (clay minerals -sericite zones), advanced argillic zones (alunit-pyrophyllite, as reported by Helman, 2010) and prophylitic zone (chlorite-epidote-calcite-clay minerals zone). Argillic zone found at south part slope of the Tumpangpitu mount, and also Fe-oxide like limonit that form gossan cap found at the pulau Merah (Red island). In these zones also found a lot of quartz veins associated with sulphide minerals and oxide minerals, especially pyrite and hematite. In the river surrounding the Tumpangpitu area and other places, found a lot of mineral alterasions of the prophylitic assemblages, such as chlorites, epidotes, calcites and quartzs. Sulphide and oxide such as pyrites, chalcopyrites, malachites hematites usually found associate with the alteration silicate mineral and quartz veins.

Most of the altered rocks of Gunung Manis hill (Petak 56) and the alluvial deposits, usulally contain a gold mineralization, associated with the present of quartz-sulphide veins dan lack of carbonate veins (1-4 cm of thick). Chlorites, silicas, clay minerals are the commonly secondary mineral found at this area, associated with sulphide minerals especially chalcopyrites and pyrites. Most of the local miner who extract gold mineralization mined at Gunung Manis, usually they made a 80-100 cm horizontal and vertical tunel from a surface to the 100 m depth.

Both The Gumuk Gendruwo Hill and Lompongan Hill, contain strong hidrothermaly altered granodiorites. The altered rocks at Gumuk Gendruwo showing grey white-ligh brownish grey coloured, iquigranular, 1-2 mm chrystal size, primary mineral composition are quartzs, plagioclas, minor biotite and alkali feldsfar. Most part of the primary mineral altered and replaced by some clay mineral, quartzs, chlorites, hematite-goetites, malachites and quartz-pyrite veins/veinlets (0,4-2cm). The secondary minerals asemblages may becaused by hydrothermal processes and as well as weathering (oxidation) processes. Lompongan Hill consist of altered volcanic breccia, showing strong argilitasion and oxidation. Quartz veins which associated with gold mineralization also found in the local miner pits, usulally located at about 20-30 m of depth. Native gold grains (0.2-0.4 mm size) found associated with quartz vein in one pit.

Hydrothermal Breccia

Many hydrothermal breccias types are found in the Tumpang Pitu area and surrounding. Sillitoe (1985) classified ore-related hydrothermal breccia into magmatic hydrothermal breccia, hydromagmatic breccia (phreatic and phreatomagmatic), magmatic breccia, intrusive breccia and tectonic breccia. There are at least two type of hydrothermal breccia have recognized in this research, i.e. magmatic-hydrothermal breccia and phreatomagmatic breccia, which were found at the Tumpang Pitu and Lompongan hill area (Table 1).. Magmatic hydrothermal breccia mostly occured in contact between diorite and quartz diorite. It is characterized by angular fragments/clasts supported or infilled by silica and sulphides matrix derived from hydrothermal fluids precipitation.This breccia is characterized by abundant of the juvenil clasts, indicating contact between hot magma with fluid or water. The juvenil clasts usually compossed by volcanic glass, rounded-angular shape.

Phreatomagmatic breccias are characterized by the presence of polymictic fragments, namely juvenile material and wall rock material about 0.6 to 6.4 cm in size with the degree of rounding intermediate to rounded and poorly sorted, matrix supported, consist of pyroclastic grains, from sand to clay in size with silica cement and some oxides. Most of the phreatomagmatic breccias have undergone strong alteration characterized by the presence of alteration minerals within massive vugy-altered rock such as silica ± alunite ± pyrophyllite and silica + alunite ± dickite with a vugy texture. The lithology of phreatomagmatic breccias has undergone moderate to weak alteration which is characterized by the presence of altered mineral groups such as silica + kaolinite ± dickite ± alunite and monmorillonite ± kaolinite which still show its original texture of the precursor rocks. The geometry of the phreatomagmatic breccias is in the form of pipe body and contact with sub-vertical to vertical wall rocks, mostly in the epithermal environment.

Mineralization associated with the phreatomagmatic breccias is showed by the presence of massive white silica minerals and some showing vugy filled with crystalline sulfur minerals, azurite, lazyite and covelite. The density of mineralization in the study area occurs by dissemination by filling vugy cavities (space filling). Phreatomagmatic breccias in the Tumpangpitu area refer to research conducted by Harrison (2017) based on the radiometric dating method K-Ar has an age of 2.7 million years (Late Pliocene).

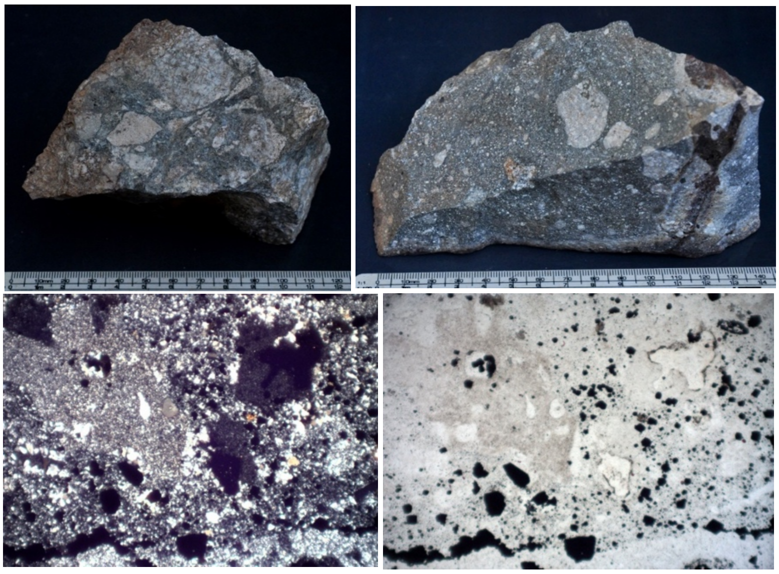

Figure 4 Handspeciment of the phreatomagmatic breccia in pit C (top). Photmicroscopic of the matrix of of the phreatomagmatic breccia.

Table 1. Characteristic hydrothermal breccia in Tumpangpitu

		Phreatomagmatic	Magmatic hydrothermal
Geometry of the breccia body		*Irregular Body*	*Pipe Body*
Contact with the wallrocks		Sub-vertikal hingga vertikal	Sub-vertical to vertical
Fragment / *Clast*	Composition	Monomic, Quartz (Silica)	Polimictic, Juvenil, rock Fragment Wallrock (altered dacite and tuff)
	Size	0,25 to 8 cm	0,6 to 6,4 cm
	Roundness	Sub-rounded to angular	Sub rounded-sub-angular
Matrix		malachite, azurite, goetite, hematite, limonite, jarosite and sulphides mineral	Pyroclastic component , clay minerlas , silica and oxide cement
Rasio Fragment and Matrix		Matrix supported	Matrix supported, grain supported
Texture		*Crackle, Jigzaw Puzzle*	*milled matrix, rock flour*
Alterasion		Advanced argillic (silica + alunite ± dickite)	Silisification (silica ± alunite ± dickite) Advanced argillic (silica + alunite

		Argillic(silica + kaolinite ± dickite ± alunite) Propilitic (paragonaticilite± monmorilonit)
Mineralization	Infilling within *vugy* (*space filling)*	Dissemination and infilling within *vugy* (*space filling)*

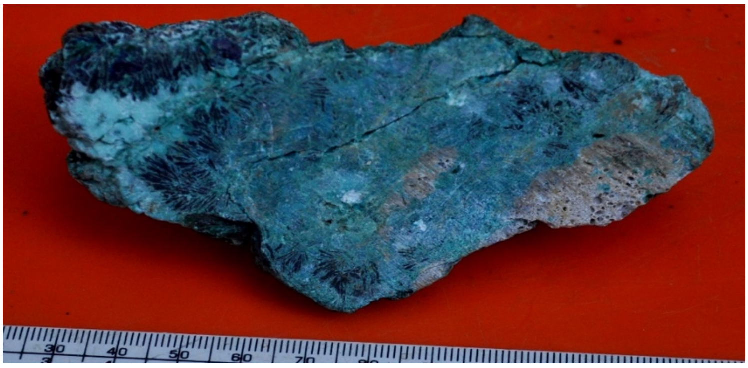

Figure 5. Azurite, mallachiite, and covellite in the phreatomagmatic breccia. Fribrous covellite and malachite infilled within matric the breccia.

Magmatic hydrothermal breccias are characterized by the presence of monomic fragments 0.25 to 8 cm in size with a angular roundness and poorly sorted. This rock is composed of mostly silica fragments are supported by matrix that altered to lazyite, azurite, goethite, hematite, limonite, jarosite and sulfide minerals. This rock has a massive structure with a jigsaw texture.The magmatic hydrothermal breccia is occured due to the interaction between the injection of magmatic fluid and meteoric water which causes the release of steam and collapses of walls that have undergone a previous silicification process. These rocks have strong altered characterized bya the presence of vugy massive silica ± alunite ± pyrophyllite and silica + alunite ± dickite.

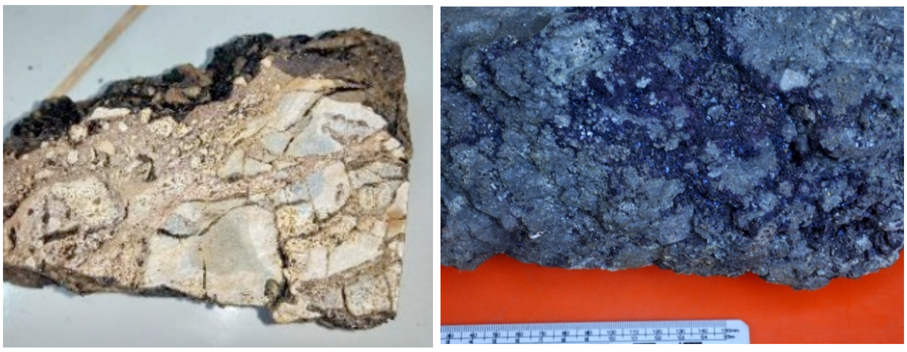

Figure 6 Magmatic hydrothermal breccia that shows Jigzaw Puzzle texture 43 Pit B West (Dynasty Hadyan Saputro and Jalu Bias F) (left). Covellite minerals relaced most of the sulphide minerals and matrix breccia.

The geometry of the magmatic hydrothermal breccia is an irregular body and contact with sub-vertical to vertical wall rocks in the epithermal and may also in porphyry environment.

Mineralization is quite well developed in magmatic hydrothermal breccia mostly occurs by filling the cavities (space filling) in the vugy texture. In the field is usually marked by a reddish color due to high oxidation processes. The mineralization formed is in the form of malachite, azurite, sulfide and oxide minerals such as hematite and goethite. The magmatic hydrothermal breccias in the Tumpangpitu area refer to research conducted by Harrison (2017) based on the radiometric dating method K-Ar has an age of 2.7 million years (Late Pliocene).

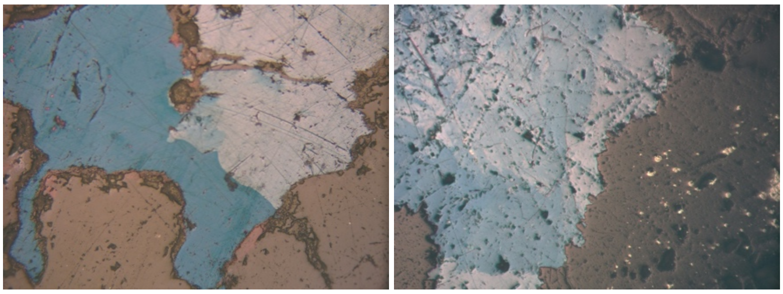

Figure 7. Photomicroscopic of bornite replaced by covellite (left). Pyrite present as inclusions within quartz (gangue) minerals which intergroth with covellite.

V. CONCLUSION

At least there are two types of hydrothermal berccias in the Tumpangpitu hydrothermal mineralization, they are Phreatomagmatic breccia and magmatic hydrothermal breccia. The geometry of the phreatomagmatic breccias is in the form of pipe body and contact with sub-vertical to vertical wall rocks, mostly in the epithermal environment. In the other hand the magmatic hydrothermal breccia is an irregular body and contact with sub-vertical to vertical wall rocks in the epithermal and may also in porphyry environment.

ACKNOWLEDGEMENT

I would like to thank management of PT. Bumi Suksesindo for supporting and permission for field work and publish this paper.

REFERENCES

Abdissalam, R., Bronto, S., Harijoko, A., and Hendratno, A., 2009. Identifikasi Gunung Api Purba Karangtengah di Pegunungan Selatan, Wonogiri, Jawa Tengah, Jurnal Geologi Indonesia, Vol. 4 No. 4 Desember 2009: 253-267.

Achdan, A. and Bahri, 1993. Geological map of the Blambangan Quadrangle, East Java. Geological Research and Developmen Centre, Bandung.

Bemmelen, van, R.W, 1949, The Geology of Indonesia, Vol. IA, Gov. Print. Office, The Hague Martinus Nijhoff

Bronto, S., Mulyaningsing, S., Hartono, G., and Astuti, B., 2008. Gunung Api Purba Watuadeg: Sumber Erupsi dan Posisi Stratigrafi, Jurnal Geologi Indonesia, Vol. 3 No. 3 September 2008: 117-128.

Carlile, J.C. dan Mitchell, A.H.G., 1994. Magmatic Arcs and associated gold and copper mineralisation in Indonesia, Journal of Geochemical Exploration, Elsevier Science, Amsterdam, 50: 92-142.

Clarke, 1992, Granitoid Rock. Hall, A., 1987, Igneous Petrology, Longman Scientific & Technical, New York Harland, W. B. dkk, A Geologic Time Scale, Cambridge University Press, New York.

Gafoer, S. and Samodra, H.,1993. Geological Map of Indonesia, Jakarta Sheet, Scale 1:1.000.000, Geological Research and Development Centre, Bandung.

Hamilton,W.B.1979, Tectonics of the Indonesian Region. Professional Paper 1078,U.S. Geolology Survey, Washington, DC.,345 p.

Hartono, G. And Bronto, S., 2007. Asal-usul Pembentukan Gunung Batur di Daerah Wediombo, Gunungkidul, Yogyakarta, Jurnal Geologi Indonesia, Vol. 2 No. 3 September 2007: 143-158.

Hellman,P.L., 2010. Tujuh Bukit Project Report on Mineral Resources, Located in East Java, Indonesia. Technical Report for Interprid Mines Limited. http://media.wotnews.com.au/esxann/01120850.pdf

Setijadji, L.D., Kajino, S., Imai, A., and Watanabe, K. ,2006. Cenozoic Island Arc Magmatism in Java Island (Sunda Arc, Indonesia): Clues on Relationships between Geodinamics of Volcanic Centers and Ore Mineralisation. Resources Geology, vol.56,no.3,267-292.

Paripurno, E.T. and Sutarto., 1996, Studi Petrokimia Magmatisme Tersier Daerah Merubetiri, Jawa Timur, Prosiding pertemuan Ilmiah Tahunan XXV Ikatan Ahli Geologi Indonesia, Bandung.

Ratman, N., Suwarti, T., and Samodra, H., 1998. Geological Map of Indonesia, Surabaya Sheet, Second Edition, Scale 1:1.000.000, Geological Research and Development Centre of Indonesia.

Setijadji, L.D., Kajino, S., Imai, A., and Watanabe, K., 2006. Cenozoic Island Arc Magmatism in Java Island (Sunda Arc, Indonesia): Clues on Relationships Between Geodinamics of Volcanic Centers and Ore Mineralisation. Resources Geology, vol.56,no.3,267-292.

Setijadji, L.D., and Maryono, A., 2012. Geology and Arc Magmatism of the Eastern Sunda Arc, Indonesia, Proceeding of Banda and Eastern Sunda Arcs 2012 MGEI Annual Convention, 26-27 November 2012, Malang, East Java, Indonesia, p.1-22.

Sapei T., Suganda, A.H., Astadiredja,K.A.S., and Suharsono, 1992, Geological map of the Jember Quadrangle, East Java. Geological Research and Developmen Centre, Bandung.

Soeria-Atmadja, R., Maury,R.C., Bellon,H., Pringgoprawiro,H., Polvé,M., and Priadi,B., 1991, The Teriary Magmatic Belt in Java, The Procceding of the Silver Jubbiles Symposium On the Dynamics of Subduction and Its Products,Yogyakarta: 98-121.

Soeria-Atmadja, R. Maury,R.C., Bellon,H., Pringgoprawiro,H., Polvé,M., and Priadi,B.,, 1993, Tertiary Magmatic Belt in Java, Journal of Southeast Asian Earth Science. 9, 13-27

Sukmandaru Prihatmoko1, Sumardiman Digdowirogo2 , dan Damar Kusumanto, 2005, Potensi Cebakan Mineral di Jawa Tengah dan Daerah Istimewa Yogyakarta. Prosiding Seminar Geologi Jawa Tengah dan Daerah Istimewa Yogyakarta, Ikatan Ahli Geologi Indonesia Pengda Yogyakarta.

Sutanto dkk, 1994, Geochronology of Tertiary Volcanism in Java, Prosiding Seminar Geologi dan Geotektonik Pulau Jawa Sejak Akhir Mesosoik Hingga Kuarter, Jurusan Teknik Geologi, Universitas Gajahmada, Yogyakarta.

Sutarto, Sutanto, and Salatun Said, 2002 Mineralisasi logam pada busur magmatik Jawa, Buletin Wimaya, UPN Pres Yogyakarta.

Sutarto, Idrus, A., Harijoko, A., Setijadji, L.,D., and Meyer, F.M. 2015. Veins and Hydrothermal Breccias of The Randu Kuning Porphyry Cu-Au and Epithermal Au Deposits at Selogiri Area, Central Java, Indonesia. J.SE Asian App.Geol, 2015, Vol 7(2) pp. 80-99 ISSN 2086-5104.

Wilson, M., 1989, Igneous Petrogenesis, A Global Tectonic Approach, Unwin Hyman, London

Sillitoe, R.H., 1994., Indonesian mineral deposits – intruductory comments, comparisons and speculations., *Journal of Geochemical Exploration*, vol. 50., pp 1-11.