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Mineralization Style of The Randu Kuning Porphyry Cu-Au and Intermediate Sulphidation Epithermal Au-Base Metals Deposits at Selogiri Area, Central Java Indonesia

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Abstract. The Randu Kuning prospect is a part of the East Java Southern Mountain Zone, mostly occupied by both plutonic and volcanic igneous rocks, volcaniclastic, silisiclastic and carbonate rocks. Magmatism-volcanism products were indicated by the abundant of igneous and volcaniclastic rocks of Mandalika and Semilir Formation and many dioritic intrusive rocks of the Late Eocene-Early Miocene magmatism. Porphyry Cu-Au and intermediate sulphidation epithermal Au-base metals mineralization at Randu Kuning have strong genetic correlation with the magmatism-volcanism processes. The mineralized dioritic intrusive rocks at the area, are distributed at the center of the depression of an ancient volcanic crater. There are many intermediate sulphidation epithermal prospect area surrounding the Randu Kuning porphyry Cu-Au. Most mineralizations both porphyry and epithermal environments are associated with the presence of quartz- sulphides veins, but not all porphyry vein types contribute in copper and gold mineralization. The early quartz-magnetite veins (particularly A and M vein types) generally not contains Cu-Au or barren, while the later sulphide bearing veins such as quartz-sulphides (AB type) veins, chalcopyrite-pyrite (C type) veins, quartz-sulphides-carbonate (D type) veins are mineralized. Mineralization contains copper and gold deposits in range at about 0.66-5.7 g/t Au and 0.04-1.24 % Cu. Whereas the epithermal level, mineralization mostly related with the presence of pyrite+sphalerite+chalcopyrite+quartz+carbonate veins and hydrothermal breccias. The epithermal veins and breccia lead to the occurences of silver, zinc and lead mineralization, it commonly contains around 0.4-1.53 g/t Au, 0.8-8.5 g/t Ag, 0.17-0.39% Cu, 0.003-0.37% Zn, 00089-0.14% Pb.

Keywords: Mineralization style, Porphyry, Epithermal, Vein, Hydrothermal breccias

INTRODUCTION

Background

The Randu Kuning Porphyry Cu-Au prospect area, situated in Selogiri, Wonogiri, Central Java Province, Indonesia. This location is reachable with four-wheel or two-wheel vehicle, about 40 km to the south-east from Solo city, or approximately 70 km east of Yogyakarta city **(FIGURE 1)**. Mineralization type of Randu Kuning prospect was interpreted as porphyry Cu-Au ore deposit and a number gold-base metals epithermal deposits in its surrounding (9, 19, 2, 3, 14, 26). The intensive erosion process has uncovered the upper parts of the porphyry deposit, whereas several gold-base metal epithermal are preserved along adjacent ridge (19). Many epithermal veins also found and crosscut into deeply porphyry veins and related potassic alteration (19, 3, 26).

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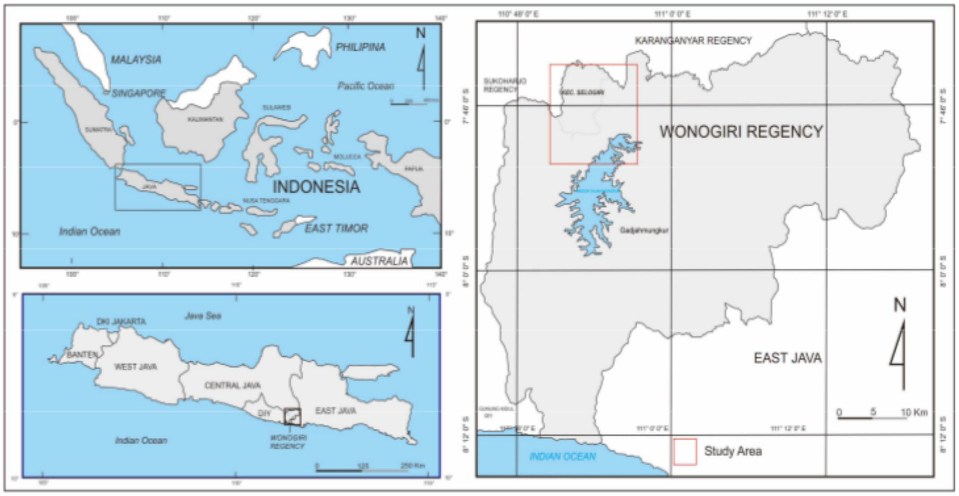

FIGURE 1. Location map of the Randu Kuning area, Selogiri district, Wonogiri regency.

Methodology

In this study, veins and rocks samples were collected systemsatically from both drilling and artisanal mining tunnel as well as surface outcrops. Secondary minerals assemblages were identified from polarisation microscopic observation (petrographic and mineragraphic analysis), X-ray diffractometer, Qemscan(Quantitative Evaluation of Minerals by Scanning Electron Microscopy) analysis. The X-ray diffractometer was conducted at the Geological Engineering Department of Gadjah Mada University using Rigaku RINT-2100. Petrographic and ore microscopic analysis were carried out at Geological Engineering Department of UPN "Veteran" Yogyakarta and Department of Mineralogy and Economic Geology, RWTH Aachen University, Germany.

GEOLOGY

Sunda-Banda arc is one of the most important six major Tertiary arcs in Indonesia extending from Sumatra through Java to east of Damar island, known has many ore deposits (11, 1). The arc is the longest arc in Indonesia, developd by northwards subduction of the Indian-Australian oceanic plate beneath the southeastern margin of Eurasian continental plate, named the Sundaland (6, 10). The western segment of the arc is abundance of low sulphidation epithermal vein systems such as mineralization in Miwah, Sondi, Martabe, Way Linggo, Ojo Lali, Cibaliung, Pongkor and Banyumas. A marked change in mineralization style is seen in the eastern arc segment, in which many porphyry copper-gold mineralization were found (1), such as in Batu Hijau, Elang, Tumpang Pitu (7, 12) and Selogiri (14, 25).

Geology and mineralization on Java

The Tertiary magmatism on Java island is divided into two periods, i.e. the Late Eocene-Early Miocene and the Late Miocene-Pliocene magmatism (20, 21). The Late Eocene-Early Miocene magmatism volcanic rocks are widespread at alongside southern part of Java, which usually has tholeiitic affinity, while the Late Miocene-Pliocene magmatism has tholeiitic, calc-alkaline to high K calc-alkaline afanities, distributed mostly on the northward from the Late Eocene-Early Miocene magmatism-volcanism. Many Eocene-Early Miocene volcanic rocks have identified and observed in few areas particularly in the Southern Mountain of Java island, including Cikotok Formation (Bayah dome) and Jatibarang Volcanic Formation in West Java, dioritic and diabasic intrusive rocks in Karangsambung Central Java and andesite intrusion (Besole Formation) Pacitan East Java. Whereas many Late Miocene volcanic rocks have also observed such as in Karangkobar Banjarnegara, Cilacap-Pangandaran, Pacitan, and Selogiri (1).

Ore mineralizations in Java island which are found ranging from Cibalium West Java to Tumpang Pitu east Java, mostly due to the magmatism-hydrothermal processes. Various types of mineralization mostly epithermal low sulphidation and porphyry Cu-Au are generally hosted on the "Old Andesite" volcanic rocks. Although other indications of mineralization types such as skarn, volcanogenic massive sulphide, polymetallic, carbonate base metals, and quartz sulphide veins are also found in some places (16), the different crustal type and source components for the magmatism processes may produce a different type of mineralization in West Java and East Java. West Java is dominated by low-sulphidation Au-Ag epithermal systems associated with Neogen-Quartenary high K to shosonitic volcanism at continental crust setting, in the other hand, Eastern Java to Sumbawa is dominated by porphyry-related Cu-Au mineralization systems associated with low to moderate K, minimum crustal contamination Middle Tertiary-Neogen magmatism (17).

Geology of the Randu Kuning area

Randu Kuning area is situated in the area where porphyry Cu-Au and epithermal Au low sulphidation occurred, at the center of the Selogiri area. The area is occupied by dioritic intrusive rocks and hydrothermal breccias as well as many veins/veinlets types. Intrusive rocks consist of hornblende-pyroxene diorite, hornblende microdiorite, and quartz diorite, while the hydrothermal breccia can be classified as magmatic hydrothermal breccia and phreatomagmatic breccia. Surface outcrops and drilling core samples observations showing that the intrusive rocks at the study area consist of hornblende-pyroxene diorite (previous researcher called as medium diorite), hornblende microdiorite and quartz diorite (24, 25).

There is at least two type of hydrothermal breccia have recognized in the research, i.e. magmatic-hydrothermal breccias and phreatomagmatic breccias, which were found at the Randu Kuning hill. Magmatic-hydrothermal breccias in research area are characterized by various irregular body, showing sub vertical to vertical in contact to the wall rocks, fragments mostly monomic, i.e. various altered diorite, angular-subrounded and larger in grain size (0.5-8.4 cm), matrix mostly consist of hydrothermal minerals (magnetite, chalcopyrite and pyrite) as open spce infillsing, fragment/matrix ratio is high (60-90 vol %) or predominantly fragment supported, texture/structures usually crackle, jig-saw and rotated fragments, no fluidization (24, 26). Phreatomagmatic breccias exhibite, irregular dyke and pipe body, subvetical-vertical, fragments/clasts consist of polimictic components including juvenil (mostly rounded) and various wall rock such as altered diorites, veins/veinlets, sandstone, quartzite, conglomerate and schist (mostly subangular), 0.2-4.5 cm in size, low fragment/matrix ratio (10-65 vol %). These breccia commonly show fluidization, associated with potassic, propyllitic and argillic alteration type, mineralization occurred in both dissemination and open space infillsing (26).

Major structures at the Randu Kuning area, dominated by relatively the NW-SE, NE-SW, and rare N-S trendings, cross-cut all of the rocks in the area. The earliest and most dominant structures in the research area are the NW-SE dextral (right) lateral-slip faults, and commonly have a longer dimension rather than other trends. These structural trends then were crosscut by NE-SW and N-S sinistral (left) lateral-slip faults. The NE-SW and N-S trend mostly concentrated in the central area. Drilling core and surface outcrop data suggest the earlier porphyry vein types were may be controlled by dextral (right) lateral-slip faults, whereas the later porphyry vein and epithermal vein types controlled by sinistral (left) lateral-slip faults (26).

HYDROTHERMAL ALTERATION AND MINERALIZATION

Alteration types

Alteration zones distribution of the researched area is controlled by the NE-SW and NW-SE trending structure. At least eight types of hydrothermal alteration at the Randu Kuning area and its vicinity had identified, i.e. 1). Magnetite+biotite±K-feldspar±chlorite (potassic) 2). Chlorite+sericite+magnetite±actinolite 3). Chlorite+magnetite± actinolite± carbonate (inner propyllitic) 4). Chlorite+epidote±carbonate (outer propyllitic) 5). Sericite+quartz+pyrite (phyllic) 6). Illite+kaolinite±smectite (intermediate argillic) 7). Illite+kaolinite± pyrophyllite± alunite (advanced argillic) and 8). Quatz+chlorite (silisic) zones **(FIGURE 2; 26)**.

The magnetite+biotite±K-feldspar± chlorite (potassic) zone are mostly distributed on microdiorite intrusive rocks body and small part of pyroxene diorite intrusive rocks especially in contact to the microdiorite intrusion of Randu Kuning hill. This zone is characterized by the presence of secondary minerals assemblage i.e. one or both of secondary biotite and, or K-feldspar associated with magnetite, actinolite, quartz and lack of carbonate minerals (19, 2, 3, 14).

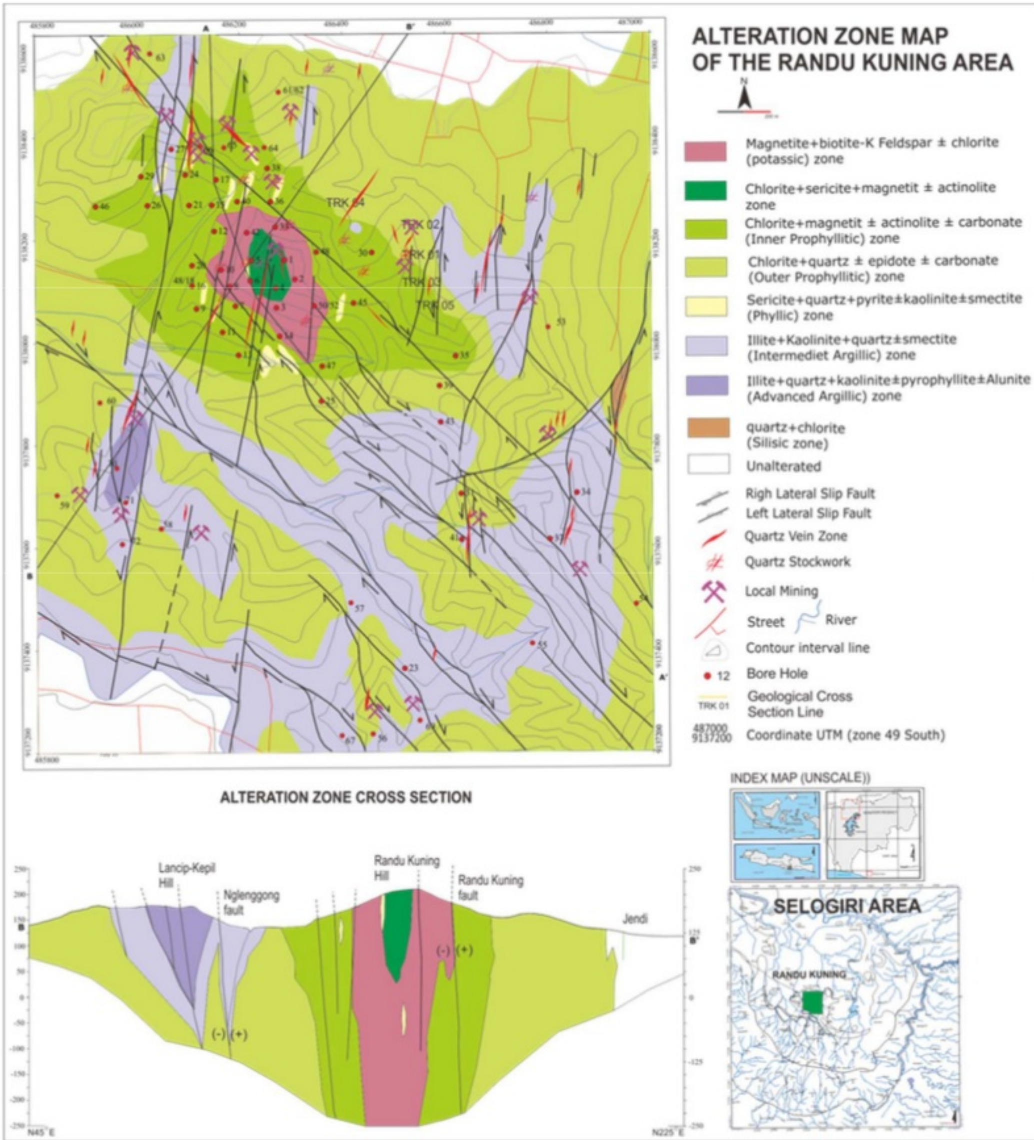

FIGURE 2. Alteration zone map of the Randu Kuning area and its vicinity (26).

Microscopically, biotite usually has dark-brown colour, fine grained, fibrous and presence predominantly in the central part of the hornblende microdiorite intrusion and gradually will decrease to the edge part of the hornblende microdiorite and the part of pyroxene-hornblende diorite. The QEMSCAN ® analysis of the potassic-altered hornblende-pyroxene diorite (sample WDD 03-47.20), shows any kind of hydrothermal secondary minerals such as biotites (15.59%), alkali-feldspars (0.7%), chlorites (12.7%), quartzes (16.96%), calcites (0.2%), kaolinites (0.02%), illites (0.56%), sericite (0.16%) and rare of ore minerals (pyrite-pyrrhotite-chalcopyrites <0.03%) (25).

The chlorite+sericite+magnetite± actinolite is widespread on the upper part of the magnetite+biotite±K-feldspar±chlorite (potassic) characterizing by the dominant of chlorite and sericite, although other secondary minerals such as magnetite, quartz, and sometimes actinolite are still found. The chlorite+sericite+magnetite± actinolite zone is developd on the small upper part of hornblende microdiorite. The chlorite+magnetite+±actinolit± carbonate alteration type is commonly recognised between magnetite+biotite±K-feldspar± chlorite (potassic) zone and chlorite+ epidote±carbonate (outer propyllitic) zone. The zone mostly is widespread in pyroxene-hornblende diorite rocks, and within small part of hornblende microdiorite. In some places this alteration zones seen cut to minerals assemblage of the magnetite+biotite±K-feldspar±chlorite (potassic) zone and gradually outward changed to chlorite+epidote±carbonate (outer propyllitic) zone. The chlorite+ epidote±carbonate, (outer propyllitic) alteration zone is widespread on pyroxene-hornblende diorite rocks and small part of quartz diorite, gradually from the inner propyllitic to least altered rock, comprising of chlorites, epidotes, carbonates and quartz. The illite+kaolinite ±smectite, (intermediate argillic) zone appears mainly adjacent to breccia and fault zone, especially in the epithermal prospect area, which is characterized by the presence of clay minerals. Illite, kaolinite and smectite are the main minerals identified in the vein samples suggesting structural controlled argillic alteration (14). The illite+kaolinite± pyrophyllite± alunite (advanced argillic) is situated at the center of Kepil hill, southwest of the Randu Kuning hill, comprising mostly illite, pyrophyllite, kaolinite, quartz and lack of alunite, carbonate and chlorite. The quatz+chlorite (silisic) zone is restricted found at the fault zones, both within drilling core data and surface outcrop, consist of quartz, sericite, carbonate, clay minerals and opaque minerals. It is mostly related to the phreatomagmatic hydrothernal breccia occurence of the epithermal systems. The sericite+quartz+pyrite (phyllic) alteration is commonly appear in the fault structure zones, locally overprint to the potassic alteration and inner propyllitic zone, on hornblende-pyroxene diorite rocks, microdiorite hornblende as well as quartz diorite (19, 2, 3, 14). This zone is characterized by retrograde silica-sericite-chlorite-pyrite assemblages, which is mostly limited to fault zones or selvages to late-stage quartz-pyrite veins likened to D veins (3).

Mineralization Prospect

On the basis of many parameters such as pattern and type of hydrothermal alteration, veins type, gangue and ore minerals assemblages, fluid inclusions, the Randu Kuning hydrothermal mineralization at Selogiri is likely porphyry Cu-Au to intermediate sulphidation epithermal Au-base metals. There are at least eight mineralization prospects area at the Randu Kuning and its vicinity, they are Randu Kuning porphyry Cu-Au prospect and many intermediate sulphidation epithermal Au-base metals prospects including Bukit Piti-Tumbu, Gawe, Geblak, Jangglengan, Lancip-Kepil and Randu Kuning South prospects (26). Most mineralizations in the researched area are associated with the presence of some sulphides such as chalcopyrite, pyrite, pyrrhotite, bornite, sphalerite, galena, and chalcocite. The copper-gold resource of the Randu Kuning porphyry prospect comprises 90.9 Mt at 0.35 g/t Au and 0.10% Cu, using a cut-off grade of 0.2 g/t AuEq (15).

Mineralization Style

Although many porphyry and epithermal vein types are found, but not all vein contribute in copper and gold mineralization. The early quartz-magnetite veins (particularly A and M veins) generally not contains Cu-Au or barren, while the later sulphide bearing veins mostly are rich of copper and gold. Mineralization style recognised at the Randu Kuning area can be summarized as follows (26):

Porphyry environment

- Quartz-sulphide veins mineralization. Some barren quartz veins are recognised in the deeper portion of some intrusions, and mostly associated with the presence of magnetite but without sulphides (A and M veins) **(FIGURE 3 A; B)**. It may due to by the high temperature, during the veins were developd. Based on the fluid inclusions analysis of A and M veins, the temperature of hydrothermal fluid is at >600°C, and it was not condition for gold-copper precipitations. In the upper portion and later stage or at the time of the ore fluids ascending, the quartz veins accompanied by minor sulphides and can develop AB veins (formed by the sulphides filling at central of the A veins), C veins (chalcopyrite-pyrite veins) **(FIGURE 3 C; D)**, and on the reactivated lamination parting of laminated M veins (2, 3). These quartz-sulphides veins are cotablemmonly associated with the Au-Cu mineralization. Stockwork AB vein cut by C style chalcopyrite vein in WDD8-1384m comprising 1 g/t Au; 2570ppm Cu (3).

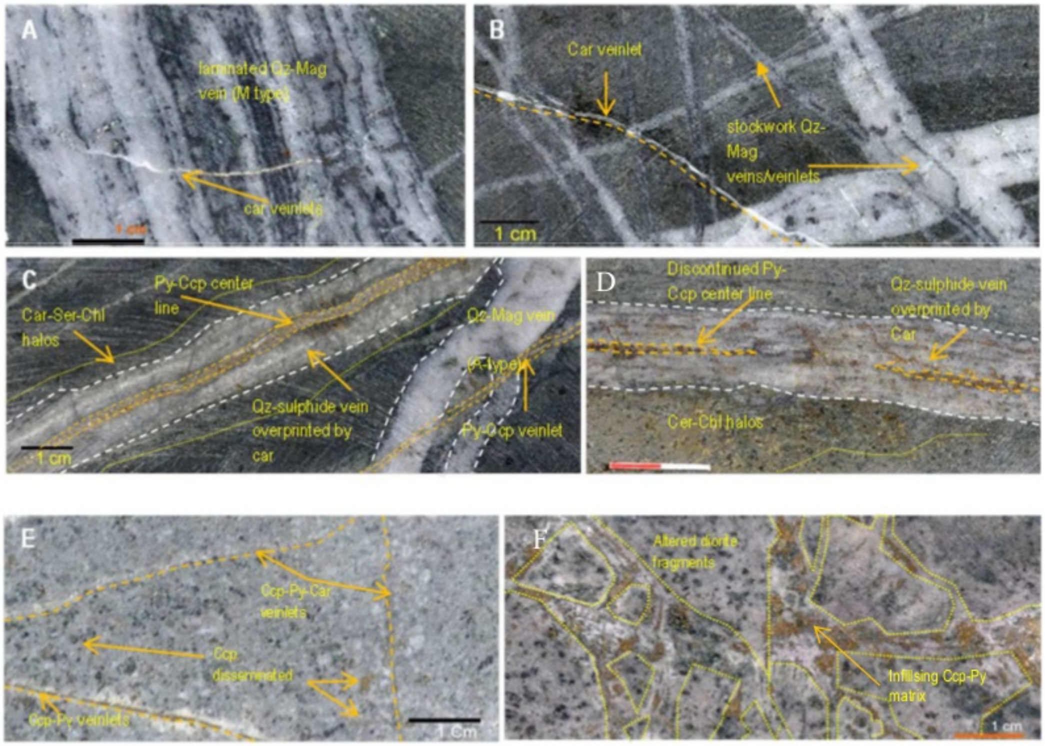

FIGURE 3. Some barren quartz-magnetite veins in the hornblende microdiorite intrusion. A) Laminated quartz-magnetite vein cut by carbonate fracture infills; B) Stockwork linear quartz-magnetite (A style veins) cross-cut by carbonate veinlet; C) B vein type with pyrite-chalcopyrite center line (left) and quartz-magnetite A vein cut by pyrite-chalcopyrite veinlet (C vein type); (D) AB vein with discontinued chalcopyrite-pyrite center line; E). Disseminated chalcopyrite-pyrite on prophylllitized hornblende-pyroxene diorite; F). Disseminated chalcopyrite-pyrite within magmatic hydrothermal breccia.

Disseminated sulphides mineralization. It was commonly found as:

1. Disseminated chalcopyrite associated with magnetite-actinolite **(FIGURE 3)**
2. Magmatic hydrothermal breccias matrix. Many of them comprising dissemination of chalcopyrite-magnetite-pyrite with quartz and actinolite.
3. Irregular fracture fills within quartz-magnetite sheeted veins.

Disseminated magnetite-chalcopyrite mineralization in WDD18-336.9m comprising 102g/t Au;1080ppm Cu and in WDD8-148.3m containss 1.74g/t Au; 2550ppm Cu (3).

- Mineralization in D vein type comprises quartz, sulphides and carbonate with prominent silica-sericite±pyrite alteration salvages (**FIGURE 3**). D vein is distinguished to epithermal veins by width, banding/center line as well as contact with the wall rocks. This vein is the latest vein in porphyry environment or may as a transition from porphyry to epithermal envoronment. D veins most common occurred within fault zones, overprinting of earlier barren quartz+magnetite veins, quartz-sulphides veins and disseminated sulphides mineralization (26). It may contains locally elevated Au to 5 g/t Au, 1.1 g/t Ag and 292 g/t Cu (in DDH WDD18-358.4m) with typically low Ag:Au ratios of 0.2 (2,3).

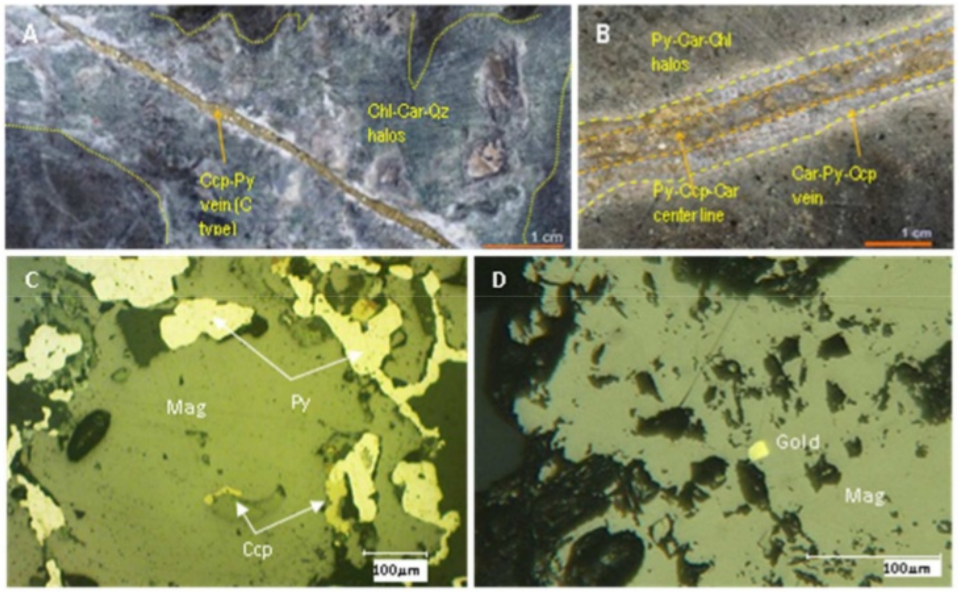

FIGURE 4. A) Propylitic-altered microdiorite cut by pyrite-chalcopyrite C style veinlets with silica-chlorite-carbonate halos (WDD26-273.15). B Quartz-pyrite-carbonate (D style vein) with sericite selvage (WDD 45-335.50). Bottom: Photomicrograph polished section under the reflected light of some samples containsing oxides, sulphides and gold C). Magnetite grains are replaced by pyrite and chalcopyrite. Sample: WDD 49-369.60 D).Inclusion free gold within magnetite. Sample: WDD 19-82.40.

Gold and copper mineralization in porphyry environment associated with mostly the presence of sulphides particularly chalcopyrite in AB, C, D veins as well as chalcopyrite disseminated, in temperature at about 300°C to >600°C and salinity ranges between 16-72 wt.% NaCl equiv. In this environment, copper and are likely transported together as chloride complexes ($CuCl^0$ and $AuCl^{2-}$) in magnetite stability field. The chlorite complexes then react with existing magnetite to produce free gold and chalcopyrite (Equation 1). Many of replacement ore texture, show many chalcopyrite replacing magnetite and minor bornite associated with gold mineralization (**FIGURE 3; 4**).

$$Fe_3O_4+6H_2S+AuCl^{2-}+3CuCl^0+7/2H_2O \leftrightarrow 4Au^0+3CuFeS_2+7H^++11Cl^-+7/4O_2 \ldots\ldots\ldots..1)$$

magnetite chloride complexes gold chalcopyrite

Hence, the Randu Kuning porphyry Cu-Au deposit is chalcopyrite- rich ore rather than bornite- rich ore. Arif and Baker (2004) suggested that porphyry Cu-Au deposits with chalcopyrite-rich ores are more likely to have a higher proportion of free gold and different with those of bornite-rich ores, where gold mostly occurred within copper sulphide grains as an invisible gold within the sulphide structure. The gold and copper grade in the Randu Kuning is mostly associated with the presence of chalcopyrite both in quartz-sulphides veins and or as a replacement in magnetite grains (**FIGURE 4**).

Epithermal Environment

In the Randu Kuning epithermal prospects, gold and base metals mineralization mostly associated with sulphides+quartz+carbonate veins and hydrothermal breccias (**FIGURE 5**). Many sulphides such as pyrite, chalcopyrite, sphalerite and lack of galena within open space hydrothermal breccia also have important role in gold-silver-zinc-lead mineralization, particularly in the epithermal environment. Brecciated pyrite-carbonate vein in Geblag (WDD 54 depth 167-169m) containss 0.63-2.229ppm Au, 28.1-31.4ppm Ag, 784-1150ppm As, 0,45-0.65% Cu, 301-640ppm Pb and 0.054-0.57% Zn. Hydrothermal breccia at the Jangglengan prospect has an important role in Au-Zn-Ag mineralization. Drilling core samples of WDD 69 depth 70-76m comprising 0.3-1.08ppm Au, 1-1.4 ppm Ag, 33-195ppmPb, 182-2010ppm Zn and 13-56ppm As. In **FIGURE 5**, free gold grain is found as inclusion within galena, in sphalerite-galena-pyrite-chalcopyrite-carbonate vein.

In the epithermal environment, gold and copper usually are transported in a different ion complexes. Au is transported as the thio complexe [Au(HS)2-; Au2(HS)2-S2- and HAu(HS)2-] in phyrite stability field, while Cu is preferably transported as chloride complex in the hematite stability field (Equation 2; 3).

$4\,Au\,(HS)_2^- + 2H_2O + 4H^+ \leftrightarrow a\,Au^0 + 8H_2S + O_2$……………………………………….2)
thio complex *gold*
$2\,CuCl^0 + Fe_2O_3 + 4SO_4^- + 6\,H^+ \leftrightarrow 2\,Cu\,Fe_2S + 2Cl^- + H_2O + 8\,O_2$……………3)
chloride complex hematite *chalcopyrite*

$ZnCl + H_2S \leftrightarrow ZnS + 2H^+ + Cl^-$………………………………………………….4)

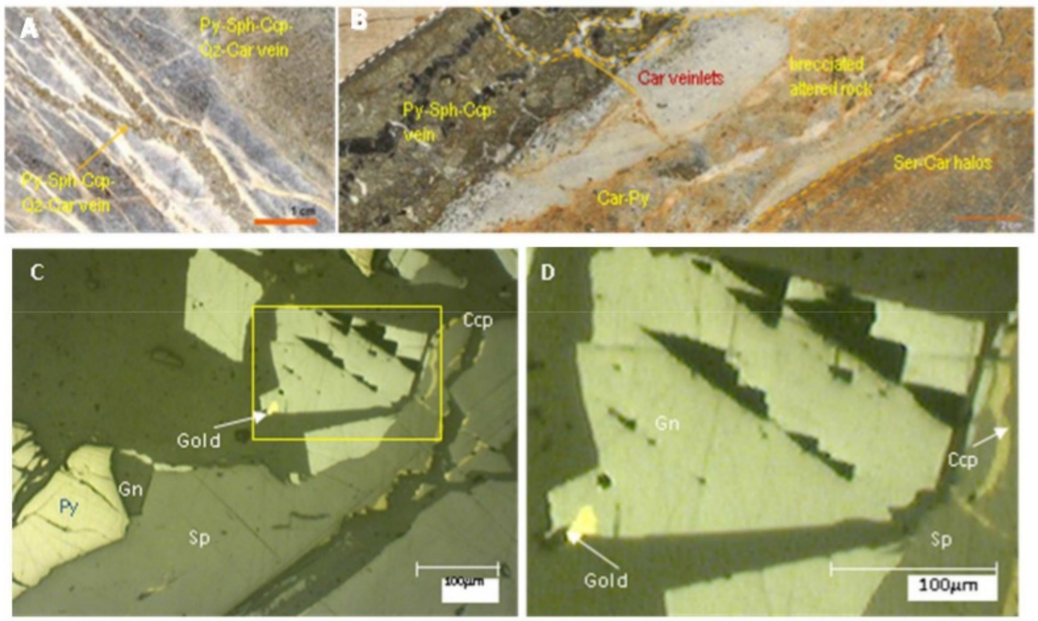

FIGURE 5. Epithermal veins type which contribute to Au-Ag base metals mineralization. A) Pyrite-chalcopyrite-silica-carbonate vein with sericite selvage (Location deep porphyry Randu Kuning, WDD 19-449.75). B) Pyrite-sphalerite-carbonate vein with sericite selvage (Location: Jangglengan, WDD54-156.80). Bottom: Photomicrograph polished section under the reflected light of sample containsing sulphides and gold. C) Sphalerite-galena-pyrite-chalcopyrite assemblage and free gold grain replaced galena. Sphalerite was replaced by chalcopyrite and galena. D). Magnification of image C. Sample: 52 WDD 19-64.75.

CONCLUSIONS

Many types and stages of veins both porphyry and epithermal environment were recognized in the researched area, but not all vein types contributed in metals mineralization. The early quartz-magnetite veins (A and M veins) generally not contains Cu-Au or barren, while the later sulphide bearing veins mostly are rich of copper and gold (AB, C, D and epithermal veins). Some D style and or epithermal veins comprising sphalerite-pyrite-carbonate and contains no chalcopyrite, magnetite and lesser bornite indicating low temperature environment formed at the deeper porphyry levels cross-cut many high temperature early quartz-magnetite porphyry type veins (A and M veins).

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REFERENCES

1. J.C.Carlile, and A.H.G., Mitchell, "Magmatic Arcs and Associated Gold and Copper Mineralization in Indonesia", Journal of Geochemical Exploration, Elsevier Science, Amsterdam, 50: 92-142. (1994)
2. G. Corbett, , "Comments on The Exploration Potential of The Wonogiri Porphyry Cu-Au Project, Central Java, Indonesia", Corbett Geological Services Pty. Ltd., Unpublished, 27 p.(2011)
3. G.Corbett, "Further Comments on The Wonogiri Porphyry Cu-Au Project Central Java, Indonesia, Corbett Geological Services Pty. Ltd., Unpublished, 37 p. (2012)
4. L.B. Gustafson, dan J.P Hunt, "The Porphyry Copper Deposit at El Salvador, Chile", Economic Geology, v (1975).
5. R.Hall, "Cenozoic Geological and Plate Tectonic Evolution of SE Asia and the SW Pacific: Computer-based Reconstructions, Model and Animations", Journal of Asian Earth Sciences 20 (2002) 353-431. (2002).
6. W.B.Hamilton, Tectonics of the Indonesian Region. Professional Paper 1078,U.S. Geology Survey, Washington, DC.,345 p. (1979).
7. P.L.Hellman, "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. (2010).
8. A. Idrus,"Petrology, geochemistry and compositional changes of diagnostic hydrothermal mineral within the Batu Hijau porphyry copper-gold deposit, Sumbawa Island, Indonesia". Doctor dissertation, RWTH Aachen University, 352 p. (2005).
9. A.Imai, J.Shinomiya, M.T.Soe, L.D.Setijadji, K.Watanabe, and I.W. Warmada, "Porphyry-Type Mineralization at Selogiri Area, Wonogiri Regency, Central Java, Indonesia", Resources Geology, vol.57, no. 2:230-240. (2007).
10. J. A.Katili, "Evolution of the Southeast Asian arc complex", Geol. Indon. Jakarta, 12: 113-143. (1989).
11. T.M. van Leeuwen, "25 Years of Mineral Exploration and Discovery in Indonesia, Jornal of Geochemical Exploration", Elsevier Science, Amsterdam, 50: 13-89. (1994).
12. A. Maryono, L.D.Setijadji, J.Arif, R.Harrison, E. Soeriaatmadja, "Gold, Silver and Copper Metallogeny of the Eastern Sunda Magmatic Arc Indonesia, Proceeding of Banda and Eastern Sunda Arcs", MGEI Annual Convention, 26-27 November 2012, Malang, East Java, Indonesia, p.23-38. (2012).
13. E.Marcoux, and J.P.Milesi, "Epithermal gold deposits in West Java, Indonesia: geology, age and crustal source", In: T.M. van Leeuwen, J.W. Hedenquistt, I.P.James, and J.A.S. Dow (Editor), Indonesian Mineral Deposits-Discoveries of the Past 25 Years, Journal Geochemical Exploration, 50:393-408. (1994).
14. A. Muthi, I.G.Basten, I.G.M Suasta, and N.E.W Litaay, "Characteristic of Alteration and Mineralization at Randu Kuning-Wonogiri Project", Proceeding of Banda and Eastern Sunda Arcs 2012 MGEI Annual Convention, 26-27 November 2012, Malang, East Java, Indonesia, p. 117-132. (2012).
15. P.L. Nightingale, "Report on Activities for the Quarter Ended 30 September 2014", Augur Resources Ltd. 11 p. (2014).
16. L.D.Setijadji, S.Kajino, A Imai, and K.Watanabe, "Cenozoic Island Arc Magmatism in Java Island (Sunda Arc, Indonesia): Clues on Relationships between Geodynamics of Volcanic Centers and Ore Mineralization", Resources Geology, vol.56, no.3,267-292. (2006).
17. L.D.Setijadji, and A.Maryono, "Geology and Arc Magmatism of the Eastern Sunda Arc, Indonesia", Proceeding of Banda and Eastern Sunda Arcs, MGEI Annual Convention, 26-27 November 2012, Malang, East Java, Indonesia, p.1-22. (2012).
18. R.H.Sillitoe, "Porphyry Copper Systems", Economic Geology v.105, pp.3-41, (2010).
19. I.G.M Suasta, and I.A.Sinugroho, "Occurrence of Zoned Epithermal to Porphyry Type Cu-Au Mineralization at Wonogiri, Central Java", Proceeding of The 36th HAGI and 40th IAGI Annual Convention. (2011).
20. R.Soeria-Atmadja, R.C.Maury, H., Bellon, H Pringgoprawiro, M., Polvé, and B. Priadi, "The Tertiary Magmatic Belt in Java, The Proceeding of the Silver Jubilee Symposium On the Dynamics of Subduction and Its Products",Yogyakarta: p. 98-121. (1991).
21. R.Soeria-Atmadja, R.C.Maury, H.Bellon, H.Pringgoprawiro, M.Polvé, and B.Priadi, "Tertiary Magmatic Belt in Java", Journal of Southeast Asian Earth Science. 9, 13-27. (1994).

22. Surono, B.Toha, and I.Sudarno, “Geological map of the Surakarta-Giritontro Quadrangles Java”, Geological Research and Development Center, Bandung. (1992).
23. Sutarto, A Idrus, F. M.Meyer, A.Harijoko, L.D.Setijadji, and R Danny, “The Dioritic Alteration Model of The Randu Kuning Porphyry Cu-Au, Selogiri Area, Central Java”, Proceedings International Conference on Georesources and Geological Engineering, December 11-12, 2013 Yogyakarta, ISBN 978-602-14066-5-6. p.122-132. (2013).
24. Sutarto, A.Idrus, S.Putranto, A.Harijoko, L.D Setijadji, F.M Meyer, and R Danny, “Petrology and Geochemistry of the Intrusive Rocks at The Randu Kuning Prospect Porphyry Cu-Au Deposit, Selogiri Area”, Central Java. CD Proceeding of The 43rd IAGI Annual Convention and Exhibition Jakarta, 15-18 September 2014. ISBN 978-979-8126-27-7. (2014).
25. Sutarto, A.Idrus, A Harijoko, L.D Setijadji, F.M Meyer, and R. Danny, “Characteristic of The Fluid Inclusions in Quartz Veins at The Randu Kuning Porphyry Cu-Au Deposit, Selogiri, Central Java”, Prosiding Seminar Nasional Kebumian X-2015 Fakultas Teknologi Mineral UPN “Veteran” Yogyakarta 18-19 November 2015 No. ISBN 978-602-8206-67-9. p. 208-220. (2015).
26. Sutarto, A.Idrus, A.Harijoko, L.D. Setijadji, and F.M.Meyer, “Veins and Hydrothermal Breccias of The Randu Kuning Porphyry Cu-Au and Epithermal Au Deposits at Selogiri Area, Central Java, Indonesia”. J.SE Asian Appl.Geol., 2015, Vol. 7(2),pp.80-99.ISSN 2086-5104. (2015).

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