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FOREWORD

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Veining Paragenetic Sequence of The Randu Kuning Porphyry Cu-Au Deposit

At Selogiri Area, Wonogiri

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Abstract

Many Tertiary hydrothermal altered dioritic composition intrusive rocks were found at the Randu Kuning area and its vicinity, Selogiri, including hornblende microdiorite, pyroxene diorite and quartz diorite. The hydrothermal fluids which responsible for the alteration and mineralization at the area is associated with the occurrence of the hornblende microdiorite intrusion.

The alteration zone at the Randu Kuning area and its vicinity can be divided into several hydrothermal alteration zones, such as potassic zone (magnetite-biotite-K feldspar), prophyllitic zone (chlorite-magnetite-epidote-carbonate), phyllic zone (quartz-sericite-chlorite) and argillic zones (clay mineral-sericite). The alteration pattern in the Randu Kuning porphyry Cu-Au deposit is typically a diorite model characterising by the domination of potassic alteration and prophyllitic zone. Phyllic and argillic alteration types are restricted found within the fault zones.

A lot of porphyry vein types were found and observed at the Randu Kuning area, and classified into at least seven vein types. The paragenetic sequence of those veins from the earliest to the latest respectively are 1). Magnetite-chalcopyrite±quartz-biotite veinlets, 2). Quartz±magnetite (A type)veins, 3). Banded/Laminated quartz-magnetite (M type) veins, 4). Quartz±K feldspar (B type)veins, 5). Quartz with thin centre line sulphide (AB type) veins, 6). Pyrite±chalcopyrite (C type) veinlets, and 7). Pyrite-quartz±chalcopyrite±carbonate (D type) veins. Gold and copper mineralisation of the Randu Kuning Porphyry Cu-Au deposit, mostly related to the presence of quartz veins/veinlets containing sulfide *i.e.* Quartz with thin centre line sulphide veins, Pyrite±chalcopyrite veinlets, and Pyrite-quartz±chalcopyrite±carbonate veins.

Key words: porphyry, veins, paragenetic sequence

Introduction

The Randu Kuning Porphyry Cu-Au prospect area is situated at Selogiri district, Wonogiri regency, Central Java, 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. The Randu Kuning area and its vicinity is a part of the East Java Southern Mountain Zone, mostly occupied by both plutonic and volcanic igneous rocks, volcanic clastic rocks, silicic clastic rocks as well as carbonate rocks. Magmatism and vulcanism in this area is represented by the Mandalika Formation consisting mostly volcanic igneous rocks such as andesit-dacitic lavas, volcanoclastic rocks namely dacitic tuffs, and volcanic breccias. The rock unit was intruded by dioritic intrusive rocks. Volcanoclastic rocks of the Semilir Formation, as a product of the huge eruption, are exposed and scattered at the south of Selogiri area such as tuffs, lapilli tuffs, dacitic pumice breccias, tuffaceous sandstones and tuffaceous shales.

Many dioritic composition intrusive rocks were found at the Randu Kuning area, both pre-mineralisation intrusive rocks and syn-mineralisation intrusive rocks as well as post-mineralisation intrusive rock. However, it is difficult to distinguish this kind of dioritic intrusive in the area, due to the similar composition and texture with varying relationship to alteration-mineralization. Imai *et al.* (2007) have identified three different type of intrusive rocks, namely hornblende andesite porphyry, hornblende diorite porphyry and hornblende diorite. Muthi *et al.*, (2012) recognized there are at least four type diorite at the Randu Kuning area *ie.* coarse grain diorite, medium diorite, microdiorite and porphyritic plagioclase diorite.

Mineralisation type of Randu Kuning prospect was interpreted as a porphyry Cu-Au ore deposit and a number gold-base metals epithermal deposits in its surrounding (Imai *et al.* 2007; Suasta and Sinugroho, 2011; Corbett, 2011, 2012 and Muthi *et al.*, 2012). The intensive erosion process has uncovered the upper parts of the porphyry deposit, whereas several gold-base metal epithermal are preserved along adjacent ridge (Suasta and Sinugroho, 2011). Many epithermal veins also found and crosscut into deeply porphyry veins and related potassic alteration (Suasta and Sinugroho, 2011; Corbett, 2012). In this study will be focused on the paragenetic sequence of the porphyry vein type only.

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Porphyry copper-gold deposits and epithermal gold-base metal deposits are both associated with subduction related at convergen plate margins and many are found and spread in the southwest Pasific rim (Corbett and Leach, 1996). Although the two deposit types have a different alteration and mineralization characteristic, but commonly show a close spatial and temporal relationship (Hedenquist *et al.*, 1998; Corbett, 2008; Sillitoe, 2010). Related the magmatic source, Corbett (2011) suggested the possible mechanisms for the formation low sulphidation epithermal Au overprinting the porphyry Cu-Au system at the Randu Kuning, that are a). The gold-base metal epithermal were deposited from the cooling magmatic source at depth as a late stage event of the main porphyry Cu-Au system, and b). The epithermal Au related with the emplacement of new magmatic source at depth.

Suasta and Sinugroho (2011), had identified four types of hydrothermal alteration, *i.e.* potassic type, prophyllitic type, argillic type and phyllic type and reported that the hornblende microdiorite was potassic-propylitic altered and mineralize, otherwise the hornblende diorite was propylitic altered only. Retrograde phyllic (silica-sericite-chlorite-pyrite) only locally overprints prograde potassic-prophyllitic zone, mainly adjacent to fault zone and breccias (Corbett, 2012). In over all, the alteration zone are dominated by potassic and prophyllitic type, and lacking with argillic and phyllic type. A dioritic composition range of the intrusive rocks type and the domination of the potassic and prophyllitic zone, based on the porphyry alteration model (Pirajno, 1992;2009) suggested that the alteration model of the Cu-Au porphyry ore deposit in the study area is more similar to the diorite model rather than the quartz monzonite model.

Method

This paper is a preliminary study which is part of the dissertation research. The data used in the paper is limited to the field observation data and drilling core logging both polarisation microscopic and megascopic observation. The laboratory analyses including rock geochemistry, mineral geochemistry, fluid inclusion and scanning electron mapping have been done.

Geology of the Selogiri Area

There are many rock types found at the Selogiri area and its surrounding, such as volcanic breccias, andesite lavas, tuffs, and many igneous intrusive rocks such as diorites and andesites of the Miocene Mandalika and Semilir Formation, unconformably underlie Quaternary volcanic rocks of Lawu and Merapi volcanos. Most of the Tertiary rocks have been strongly hydrothermal altered, that caused rock forming primary minerals (feldspars, hornblendes, pyroxens), were replaced by secondary minerals (chlorites, carbonates, quartzs, hematites). These

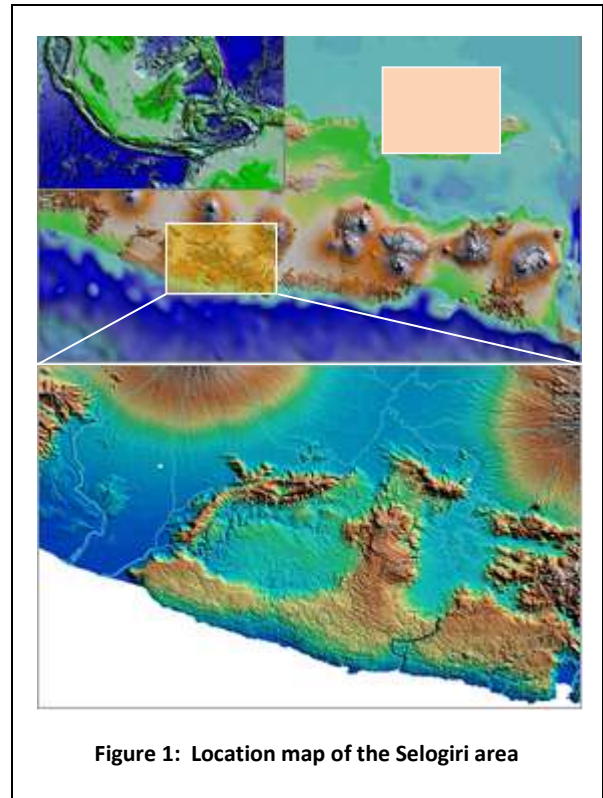


Figure 1: Location map of the Selogiri area

rocks lithostratigraphically could be grouped into 6 (six) rock units, *i.e.*: Pumice Breccia Rock Unit of Semilir, Volcanic Breccia Rock Unit of Mandalika, Intrusive Rocks, Hydrothermal Breccia, Volcanic Breccia of the Lawu Volcano, and Aluvial Deposit.

Many dioritic composition intrusive rocks were found at the research area, including pre-mineralisation intrusive rocks, syn-mineralisation intrusive rocks as well as post-mineralisation intrusive rock. In reality, it's difficult to distinguish of the dioritic rocks type in the area due to their similar composition. Based on the observation both on the surface outcrops and drilling core samples, the intrusive rocks at the study area consists of feldspar diorite (as a xenolith within pyroxene diorite), pyroxene diorite (previous researcher called as medium diorite), hornblende microdiorite and quartz diorite (coarse diorite).

Alteration and mineralization

Suasta and Sinugroho (2011), had identified four types of hydrothermal alteration at the Randu Kuning area and its vicinity, *i.e.* potassic type, prophyllitic type, argillic type and phyllic type. Potassic alteration zone scattered on hornblende microdiorite intrusive rocks body and small part of pyroxene diorite intrusive rocks especially in the contact area to the hornblende microdiorite intrusion of Randu Kuning hill. This zone characterized by secondary

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minerals assemblage i.e. one or both of secondary biotite and/or K-feldspar associated with magnetite (Suasta and Sinugroho, 2011; Corbett, 2011, 2012 and Muthi et al., 2012). Prophyllitic alteration is less commonly recognised typically as actinolite or chlorite-epidote-magnetite alteration at the margin of the hydrothermal system (Corbett, 2012). Prophyllitic zone mostly is widespread in pyroxene diorite and quartz diorite rocks, both visible at the surface outcrop and in drill core samples. In pyroxene diorite, prophyllitic zone dominated by the chlorite-magnetite-quartz and a lesser epidote mineral assemblages. While within the quartz diorite rocks prophyllitic zone is generally dominated by the presence of the quartz-epidote-chlorite and carbonate minerals assemblages. Phyllic alteration is commonly appear in the fault structure zones, locally overprint to the potassic alteration and prophyllitic zone, on pyroxene diorite rocks, microdiorite hornblende as well as quartz diorite (Suasta and Sinugroho, 2011; Corbett, 2011, 2012 and Muthi et al., 2012). This zone characterized by retrograde silica-sericite-chlorite pyrite is mostly limited to fault zones or selvages to late stage quartz-pyrite veins likened to D veins (Corbett, 2012). Argillic zone appear mainly adjacent to breccia and fault zone, especially in the epithermal prospect area, characterized by the presence of the clay minerals. Illite and monmorillonite are the main minerals identified in the vein samples suggesting structural controlled argillic alteration (Muthi et al., 2012).

A dioritic composition range of the intrusive rocks type and the domination of the potassic and prophyllitic zone, suggested that the alteration model of the Cu-Au porphyry ore deposit in the study area is more similar to the diorite model rather than the quartz monzonite model. Although quartz diorite intrusive also were found in the area, but it crystallized after the formation of porphyry stage, which is associated with the Au-base metal epithermal mineralization stage.

Vein Type

An understanding of the veins and veinlets in the porphyry system is very important, especially in the Cu-Au porphyry deposit, as most of mineralization is associated with the presence of veins and veinlets. Many various types of veins in porphyry-type ore deposit summarized from several experts (Gustafson and Hunt, 1975; Corbett, 2008; Sillitoe, 2010; Corbett, 2012) include EB type or EDM type, M type, A type, B type, AB type, C type and D type. A lot of vein type were observed at the Randu Kuning area, both porphyry vein type and epithermal vein type. Some of them are difficult to be grouped according to the classification of previous researchers above.

Here are some vein types criteria that were found in the study area based on observations of drilling core samples and surface outcrops (using compilation of

Gustafson and Hunt, 1975; Corbett, 2008; Sillitoe, 2010; Corbett, 2012). At least seven porphyry veins type have observed, respectively from the earliest are:

- 1. Magnetite-chalcopyrite ±quartz-biotite veinlets**
 - Mostly occurred as a stringer veinlets
- 2. Quartz±magnetite (A type)veins**
 - Comprising mostly saccharoidal and transparent quartz and minor or without magnetite
 - Associating only with potassic alteration zones
 - Vein shape commonly unsymmetry, irregular and discontinue
 - It is can be a single vein, pygmatic vein, stockwork linear vein, sheeted vein and stringer vein
 - Disseminated chalcopyrite rarely present
- 3. Banded/Laminated quartz-magnetite (M type) veins**
 - Consist of magnetite and quartz with minor or without sulphide
 - Showing banded or laminated structure
- 4. Quartz±K feldspar (B type)veins**
 - Characterized by centrally terminated combstructure quartz and or feldspar in filled with lesser of fine sulphide. Some of them not in filled by sulphide
 - At Randu Kuning area this vein type are rarely recognised
- 5. Quartz with thin centre line sulphide (AB type) veins**
 - This vein types are formed by the filling at central termination within A vein by sulphides (chalcopyrite-pyrite±bornite)
- 6. Pyrite±chalcopyrite (C type) veinlets**
 - Comprising sulphide minerals (chalcopyrite-pyrite)
 - This veinlets generally narrow and there is no alteration selvages or halos
- 7. Pyrite-quartz+chalcopyrite+carbonate (D type) veins**
 - Characterized by coarse euhedral pyrite, quartz and carbonate
 - Commonly followed by silica-sericite±pyrite selvages/halos
 - Associated with phyllic zone toward to prophyllitic zone

Conclusions

The intrusive rocks at the study area consists of feldspar diorite (as a xenolith within pyroxene diorite), pyroxene diorite, hornblende microdiorite and quartz diorite. Hydrothermal fluids responsible for the alteration and mineralization is associated with the occurrence of the hornblende microdiorite intrusion.

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A dioritic composition range of the intrusive rocks type and the domination of the potassic and prophyllitic zone, suggested that the alteration model of the Cu-Au porphyry ore deposit in the study area is more similar to the diorite model rather than the quartz monzonite model. Phyllic and argillic alteration type also present, but in a limited area, especially within the fault structure zones.

Many vein type which related the formation of porphyry deposit have identified, respectively from the earliest are Magnetite-chalcocopyrite ±quartz-biotite veinlets, Quartz±magnetite (A type)veins, Banded/Laminated quartz-magnetite (M type) veins, Quartz±K feldspar (B type)veins, Quartz with thin centre line sulphide (AB type) veins, Pyrite±chalcocopyrite (C type) veinlets, and Pyrite-quartz+chalcocopyrite+carbonate (D type) veins.

References

- Corbett, G., 2011, Comments on The Exploration Potential of The Wonogiri Porphyry Cu-Au Project, Central Java, Indonesia, *Corbett Geological Services Pty. Ltd.*, p 27.
- Corbett, G., 2012, Further Comments on The Wonogiri Porphyry Cu-Au Project Central Java, Indonesia, *Corbett Geological Services Pty. Ltd.*, p 37.
- Corbett, G., and Leach, T.M.,1996, Southwest Pacific Rim Gold Copper Systems: Structure, Alteration, and Mineralization, Workshop Manual for Presented at Gustafson, L.B. dan Hunt, J.P. 1975, The Porphyry Copper Deposit at El Salvador, Chile, *Economic Geology*, v 70:pp. 857-912.
- Hartono, G., 2010, The Role of Paleovolcanism in The Tertiary Volcanic Rock Product Setting at Gajahmungkur Mt., Wonogiri, Central Java, *Dissertation, Unpublished*, 190 p.
- Idrus, A., 2008, Transport and Deposition of Copper and Gold in Porphyry Deposit: A Constraint From Microthermometry and Hydrothermal Biotite Chemistry, *Media Teknik* No.3 Tahun XXX Edisi Agustus 2008 ISSN 0216-3012 p.276-283.
- Imai, A., Shinomiya, J., Soe, M.T., Setijadji, L.D., Watanabe, K., and Warmada, I.W., 2007, Porphyry-Type Mineralization at Selogiri Area, Wonogiri Regency, Central Java, Indonesia, *Resources Geology*, vol.57, no. 2:230-240.
- Isnawan, D., Sukandarrumidi and Sudarno, I., 2002, Kontrol Struktur Geologi Terhadap Jebakan Tembaga Sebagai Arahkan Eksploitasi di Daerah Ngerjo dan Sekitarnya Kecamatan Tirtomoyo, Kabupaten Wonogiri Propinsi Jawa Tengah, *Gama Sains IV* (2) Juli 2002, p.149-157.
- Maryono, A., Setijadji, L.D., Arif, J., Harrison, R., Soeriaatmadja, E., 2012, Gold, Silver and Copper Metallogeny of the Eastern Sunda Magmatic Arc Indonesia, *Proceeding of Banda and Eastern Sunda Arcs 2012 MGEI Annual Convention*, 26-27 November 2012, Malang, East Java, Indonesia, p.23-38.
- Muthi, A., Basten, I.G., Suasta, I.G.M., and Litaay, N.E.W., 2012, 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.
- Pirajno F., 1992, *Hydrothermal Mineral deposits, Principles and Fundamental Concepts for the Exploration Geologist*, Springer-Verlag, Berlin, Heidelberg, New York, London, Paris, 709 p.
- Pirajno, F., 2009, *Hydrothermal Processes and Mineral Systems*, Springer-Geological Survey of Western Australia, 1250 p.
- 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 Geodynamics of Volcanic Centers and Ore Mineralisation, *Resources Geology*, vol.56,no.3,267-292.
- Sillitoe, R.H., 2010, Porphyry Copper System, *Economic Geology* v.105, pp.3-41, 2010.
- Suasta, I.G.M and Sinugroho, I.A., 2011, Occurrence of Zoned Epithermal to Porphyry Type Cu-Au Mineralization at Wonogiri, Central Java, *Proceeding of The 36th HAGI and 40th IAGI Annual Convention*.
- Prihatmoko, S., Digdowirogo, S., and Kusumanto, D., 2002, 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, p. 87-108.

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