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Characteristic of Hydrothermal Alteration, Ore Mineralization And Fluid Inclusion Of Watuijo Prospect, Tulungagung Regency As An Indication Of Porphyry CU System

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ABSTRACT

Watuijo Prospect is located in Panggunguni Village, Tulungagung district, East Java Province, Indonesia. The alteration rock, as a lithocap, is associated with stockwork veinlet which is filling by pyrite, malachite and azurite. The aim of this research is to characterize mineralization type using field data that analyzed by petrography, XRD, and fluid inclusion methods. The geology of research area was consist of sandstone and limestone as a wall rock that intruded by dacite as a host rock.. The hydrothermal alteration can be identified as phyllic alteration, argillic alteration and also advanced argillic alteration. Ore mineralization is characterized by disseminated sulphides such as pyrite, chalcopyrite, magnetite, bornite, sphalerite, covelite, and digenite with veinlet type are A type, AB type, and D type. Hydrothermal fluid of Watuijo Prospect is typified by high temperature (~385 to >400ºC) and high salinity (46 to 52 wt.% NaCl). It shows that the type of the deposit is Cu-Au mineralization of porphyry system.

Keyword: alteration, Cu-Au mineralization, Watuijo, Tulungagung

ABSTRAK

Prospek Watuijo terletak di Desa Panggunguni, Kabupaten Tulungagung, Jawa Timur. Batuan alterasi pada lokasi diinterpretasikan sebagai *lithocap,* yang ditemukan berasosiasi dengan urat *stockwork* yang terisi oleh mineral pirit, malakit dan azurite. Tujuan penelitian ini adalah untuk mengkarateristikkan tipe mineralisasi menggunakan data permukaan dan dianalisis dengan metode petrografi, XRD, dan inklusi fluida. Kondisi geologi lokasi penelitian tersusun oleh batupasir dan batugamping, dimana batupasir diterobos oleh intrusi dasit, yang berperan sebagai batuan induk mineralisasi. Tipe alterasi hidrotermal yang ditemukan adalah alterasi filik, argilik dan argilik lanjut. Mineral bijih yang teridentifikasi yaitu magnetit, bornit, kalkopirit, sfalerit, kovelit dan digenit yang ditemukan pada urat tipe A, AB, dan tipe D. Inklusi fluida pada batuan memiliki temperature medium-tinggi (~385 to >400ºC) dan salinitas tinggi 46 to 52 wt.% NaCl). Berdasarkan karakteristik mineralisasi, alterasi dan inklusi fluida diinterpretasikan bahwa pada lokasi penelitian memiliki potensi geologi ekonomis berupa endapan porfiri Cu-Au.

Kata kunci: alterasi, mineralisasi Cu-Au, Watuijo, Tulungagung

1. INTRODUCTION

Watuijo Prospect is an ex-traditional mining of chryssocola that located in Panggunguni Village, Pucanglaban, Tulungagung district, East Java Province, Indonesia. The wide of this area is just 150 m x 150 m. The presences of ore mineralization showed by outcrop of alteration rock that associated with stockwork vein and veinlet which filling by azurite and malachite. This research aimed to determine the type of hydrothermal deposits by investigated characteristic of hydrothermal alteration, ore mineralization, ore geochemistry and also fluid inclusion. Ore chemistry shows erratic gold and basemetal content ranging from 0.13 to 13.8 % Cu, 0.03 to 0.44 g/t Au, 2.23 to 47.7 g/t Ag, 69 to 583.6 g/t Pb, and 84.5 to 6445.5 g/t Zn.

2. GEOLOGI REGIONAL

By stratigraphically, the research area consist of from the oldest to the youngest is Mandalika formation, Nampol Formation and Wonosari Formation. Regional structural that controlled in this area has NW-SE and NE-SW orientation. Based on Widodo et al (2002), ore mineralization in this research area is concluded in East block which spread along Ponorogo to Lumajang. This mineralization was controlled by andesitic to dioritic intrusion that intruded volcanic rock Mandalika Formation, volcanic rock from Arjosari Formation, also sedimentary rock of Campurdarat Formation and also Wuni Formation and Wonosari Foration. Ore mineral that was found is native gold, chalcopyrite, pyrite, sphalerite, galena, malacite, chalcosite that associated with quartz vein/veinlet that was found in prophyllitic, argillic, advanced argillic alteration and also silicification.

3. RESEARCH METHODS

This research sample is limited to surficial data, not using subsurface data. The laboratory analyses consist of petrography of polish and thin section, XRD and fluid inclusion for several field sample.

4. RESULTS AND DISCUSSION

4.1 Hydrothermal Alteration

Hydrotermal alteration that developed in this prospect was identified by XRD method, then divided into 3 alteration types such as (1) phyllic alteration (qz-ser-py) that spread only 10% from total area that altered (2) argillic (ill-smec±kao±cb) that spread 60% from total altered area (3) advanced argillic (alu-prl-kao) that spread almost 60% from total altered. The spreading of those alteration was showed by Fig.4. Hydrothermal alteration map of research area.

4.2 Ore Mineralization and Ore Geochemistry

The vein/veinlet system that was found in research area are A, AB that was filling by chalcopyrite($CuFeS_2$), bornite(Cu_5FeS_4), magnetite(Fe_3O_4) and chalcosite(Cu_2S), and D type (Fig.1) that was filling by pyrite(FeS_2) that associated with sphalerite (ZnS), galena (PbS), covellite (CuS), hematite (Fe_2O_3) and also arsenopyrite massive vein. The vein thickness is about <1cm – 10 cm. Those vein/veinlets have N-S orientation. Ore mineral paragenetic start

from early procces is hypogen then continued by supergen process. In hypogen process, was divided into 3 zones based on hydrothermal alteration association, which are central zone which associated with phyllic alteration, then proximal zone which associated with advanced argillic alteration and the peripheral is distal zone which is associated with argillic alteration. This paragenetic will show by Table 1.

The result of ore geochemistry is the research area has Cu content about 0,13 to 13,8 % Cu, and also 0,03 to 0,44 g/t Au; 2,23 to 47,7 g/t Ag; 69 to 583,6 g/t Pb dan 84,5 to 6445,5 g/t Zn. The high content of Cu is indicate supergene process.

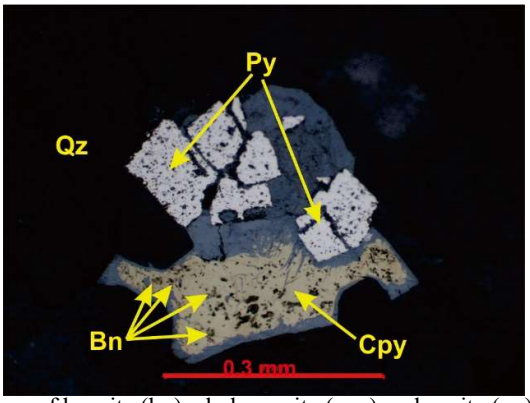

Fig 1. the appearance of bornite (bn), chalcopyrite (cpy) and pyrite (py) in type D veinlet.

4.3 Hydrothermal Fluid

The fluid inclusion was found in quartz vein sample. It dominated by 2-phase and also solid phase inclusion (Fig.3). This solid phase was characterized by appearance of halite mineral. By measurement and calculation, the temperature of fluid (Th) range 386 ºC-- 400 ºC and salinity was so high about 52.16 wt.% NaCl (Fig.2). This results indicates that hydrothermal fluid is a dominantly by magmatic fluid.

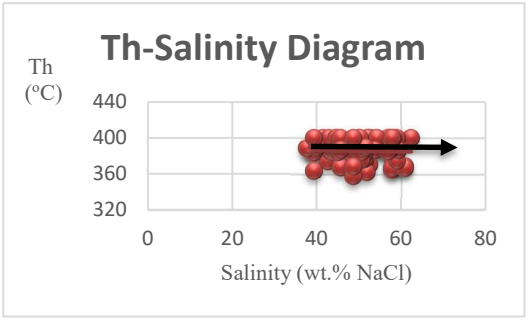

Fig 2. Th-Salinity Diagram showed high salinity, medium-high temperature

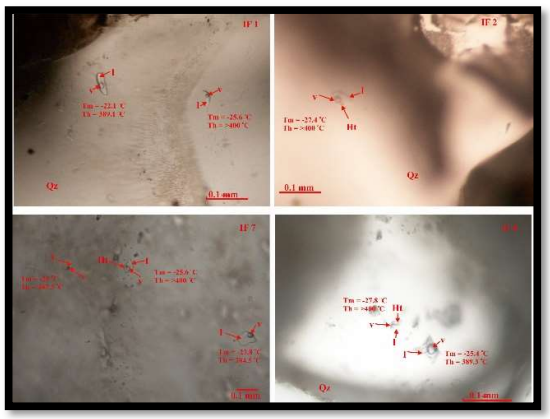

Fig 3. Appearance of biphase dominated fluid inclusion of samples.

5. DISCUSSION

The geological condition of this research area was controlled by dacite-intrusion as hostrock of mineralization. Hydrothermal alteration was characterized by low pH alteration (argillic and advanced argillic) and high silica content (Vuggy silica) that associated with magnetite, pyrite, chalcopyrite, chalcosite, bornite etc. the result of ore geochemistry indicate high Cu-content and high basemetal (Pb, Zn) content. By those results, it can be interpreted as possibility of porphyry Cu-deposit. It supported by high salinity of fluid inclusion. But, normally, porphyry system is characterized by high temperature, but in this area was not. So it can be interpreted that the area is peripheral zone of a porphyry system that form near the surface. Then compared to the ideal deposit model of Batu hijau prospect in Sumbawa, the deposit type in the research area is porphyry system that form lately in the peripheral zone of a porphyry system or in other hand, this area was a lithocap that indicate a potential porphyry Cu system that dominantly controlled by supergene process. The summary of the comparison characteristic between deposit in the research area and Batu Hijau Prospect was showed by Table 2.

6. CONCLUSION

1. Hydrotermal alteration that developed in this prospect was identified by XRD method, then divided into 3 alteration types such as (1) phyllic alteration (qz-ser-py) (2) argillic (ill-smec±kao±cb) (3) advanced argillic (alu-prl-kao).
2. Ore mineralization is characterized by pyrite, chalcopyrite, sphalerite, galena, gold (Au) in electrum and/or native gold grain, chalcocite, covellite, bornite, magnetite dan hematite. The vein/veinlet system that was found in research area are A, AB, D type and massive arsenopyrite vein.
3. The hydrothermal fluid that controlled mineralization is a dominantly by magmatic fluid (high salinity, medium-high temperature).
4. The deposit type in the research area is peripheral zone of a porphyry system that dominantly controlled by supergene process.

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ATTACHMENT

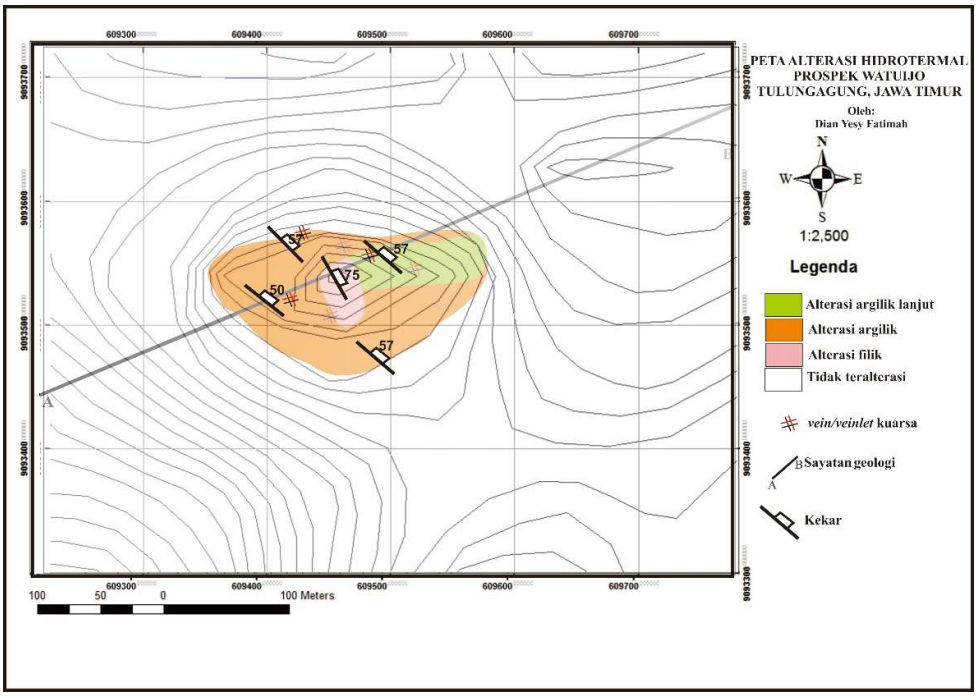
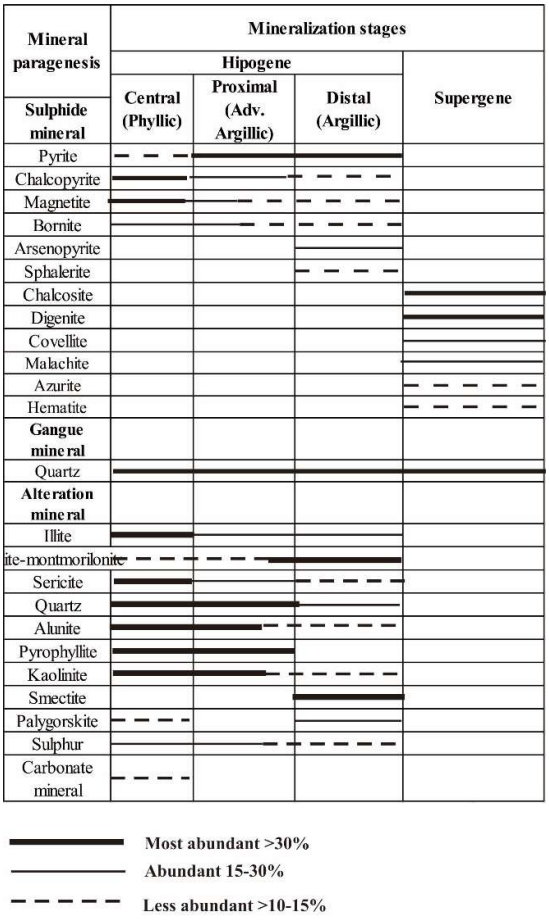


Fig. 4. Hydrothermal alteration map of research area

Tabel 1. Ore mineral paragenetic



Tabel 2. Characteristic comparison between research area and Batu Hijau ideal deposit model in Sumbawa

Characteristics	Watuijo Prospect, Tulungagung	Batu Hijau Deposit, Sumbawa
Host rock	Dacite	Tonalite
Rock texture	Porphyroafanitic	Porphyritic
Structural geology	N-S fracture, joint and fault	NW-SE and NE-SW fault
Vein/veinlet types	A type, AB type dan D typeand massive arsenopyrite vein	A,B,D type and comb quartz vein

Hydrothermal alteration	Phyllic alteration, argillic and advanced argillic alteration	*Early stage biotit-magnetit zone, late stage advanced argillic*
Mineralization	Magnetite, bornite, chalcopyrite, pyrite, chalcosite, digenite, arsenopirite, *native gold*	bornite, chalcopyrite, pyrite, chalcosite, digenite,
Cu-Au contents	0,13 to 13,8 % Cu dan 0,03 to 0,44 g/t Au	>0,5% Cu and 0.4 g/t Au
Hydrothermal fluid	Moderate temperature (~385 to >400ºC) dan high salinity (46 s/d 52 wt.% NaCl)	*prograde skarn associated has* m*oderate to high temperature (340-515ºC), salinity 25-49 wt.% NaCl*