Gold Mineralization in The Panikaban Area Banyumas Central Java Province Indonesia

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Abstract

Our research was conducted in Panikaban Area, Ponorogo Regency, Central Java, Indonesia. Based on the result of field data collection and analysis which has been carried out in the laboratory, stratigraphy study area was divided into 6 unofficial lithostratigraphy units and 2 litodem with the sequence of an old rock to young as follows: Halang volcanic breccia unit (Tmb), Halang sandstone unit (Tmbp), Kumbang andesite lava unit (Tma), Andesite intrusion (Tmi), Tapak volcanic breccia unit (Tpb), Tapak sandstone unit (Tpbp), Tapak limestone unit (Tpbg) and Alluvial (Qa).

Rock lithology conditions in the research area are also included in the category in experiencing the process of alteration and minerallization, making the study area was being divided into three zones of alteration, namely: argillic zoning, propylitic zoning, and sub-propylitic zoning. Mineralization found in the research area is relatively associated to quartz veins (veins or veinlets) in the Halang sandstone unit, as well as on the intrusion body in the study area. Ore mineralization contained in research area such as sulfide minerals, such as: pyrite (FeS_2), chalcopyrite ($CuFeS_2$), galena (Pbs) and bornite (Cu_5FeS_4). Results of the analysis of AAS (Atomic Absorption Spectroscopy) or atomic absorption spectrophotometry is used to determine the content of sulfide mineral elements contained in a sample. The analysis shows increase in sulfide mineralization which is characterized by the abundance of the elements Cu, Pb, Zn, Ag, Au, some places elements of Au increases compared with other elements.

Keywords : Stratigraphy, alteration, mineralization, vein

INTRODUCTION

Patterns and models of geological structures is crucial in determining the whereabouts of gold mineralization and other ore deposits at a certain area, and when the patterns and models of geological structures are already known, then if gold mineralization and ore being found, it will be easier to determine its existence (Nikolay A Goryachev & Franco Pirajno, 2014).This area is an example area that the gold mineralization can be found relatively well in Central Java, which until today is still being explore to obtain the existence of economical gold deposits.

Gold mineral and its accompanying minerals contained or crystallized in the veins of quartz (the magma residue/late magmatic) at the fracture/joint lines, both in the tension fracture and shear fractures (shear zones) as well as the fault lines (fault zones). Quartz veins structure follows the pattern of fractures and faults in the research area that is trending Northwest - Southeast, Northeast - Southwest, North - South and West - East. Based on analysis regional structure, Paningkaban and its surrounding area. are a tectonic shift patterns Sumatra and Java tectonic pattern (Condon WH, et all, 1996).

From the preliminary results, the geological structure and its relationship with mineralization and gold deposits in the Paningkaban area and its surrounding shows that there is an indication that the gold mineralization in quartz veins controlled by geological structure pattern. It is based on some researchers review results, that the AAS analysis result on a sample of quartz veins in tension and compression fracture shows Au element (gold) is relatively high.

Generally, based on the selected structural lines in the Paningkaban area and its surroundings show that the structure pattern of the fractures and quartz veins are trending NW- SE (Northwest - Southeast), NE - SW (Northeast- Southwest), N-S (North-South) and some E-W (East-West). Furthermore, this research proposal will continue the study measurement and detailed analysis in the alignment area to obtain the certainty of any gold deposits and models that controlled by the structure patterns in such area.

RESEARCH METHODOLOGY

The methodology of the research is focusing in the secondary data collecting along with some previous studies results both published and unpublished. The primary data begins with Landsat imagery and topography maps analysis, then followed by surface mapping (surface) with data collecting such as geology, outcrop observation, geomorphology, geological structures (faults, fractures, and folds), alteration mineralization areas, quartz veins, as well as taking rock samples for further analysis.

The equipments used in this research are geological compass, geological hammer, GPS, loupe and others. Mapping stages include; secondary data study in this designated area, morphology and topography observation, position measurement and rock samples collecting, and also infrastructures and roads observation.

Data processing stage has been carried out by the track and geological observation location map, geological map, geomorphology map, hydrology pattern map, alteration mineralization track map, and alteration mineralization zoning map making. In the end, all maps, analysis and interpretations are being combined together into the final report.

GEOLOGY

Based on the Majenang Geological Map sheets (Kastowo and N. Suwarna., 1996), geological structures are found in the form of fault, fold, straight alignment and fracture, involving Oligo-Miocene aged rocks up Holocene epoch. Faults are generally trending northwest-southeast to the northeast-southwest. The type of faults are thrust fault, normal fault and shear fault both sinistral and dextral and also involves rock aged Oligo-Miocene to Pleistocene, (Sanzhong Li, et all,.2012 Thrust fault is generally forming an arc showing slope variation of the fault plane to South until West direction, whereas normal faults can be found scattered in local area. The pattern of folds are trending Northwest-Southeast, with a slipped axis. The alignment that allegedly supposed to be fault section have a pattern spread such as fault patterns, and generally trending northeast-southwest, with few northeast-southwest, which in some place they were intersect. The fractures are generally found and well-developed on Tertiary and Pleistocene rocks.

Tectonics in this area is at least having two periods, which results in a different structure. The first structure occurs in Middle Miocene and produce thrust feature followed by the intrusion of andesite and basalt. Formation Jampang, Pemali, Rambatan, Lawak and Kalipucang Limestone are folded and faulted, especially forming normal faults trending northwest-southeast and northeast-southwest. The second period took place on Plio-Pleistocene epoch, produces strike slip fault and a thrust fault trending northwest-southeast and northeast-southwest. The Plio-Pleistocene tectonics period faults are formed generally in the boulder faults forms. Geophysical data shows that this latter tectonic activity is intensified back some normal faults (Asikin S., Handoyo A., B. Pratistho, and Gafoer S., 1992).

The geomorphology of research area is dominated by sloped hills that steep and relatively trending northeast-southwest and northwest-southeast, with the erosion level about weak until strong. In general, the landscape is controlled by lithology, geological structure and processes of erosion factors. Classification then this research area can be divided into 4 original form units (volcanic, structural, karst, fluvial), and 10 units of land forms, namely: Volcanic hills landform unit, Volcanic plateau landform unit , Intrusion hill landform unit, Anticlinal hill landform unit, Sinklinal valley landform unit, Sloped sinklinal valley landform unit, Faulted Valley landform unit, Monoclinal hills landform unit, Eroded and sloped karst landform unit and Alluvial Plain landform unit.

Based on data collection in the form of initial interpretation, previous research data, field data and laboratory analysis, the column stratigraphy of research area is being generated by the sequence of lithologies following the age from old until recent time. Basic naming technique on each lithology on the research area refers to Indonesian Stratigraphy Cipher (SSI) at 1996 by naming the unofficial unit based on the characteristics of the dominant lithology.

Based on the result of field data collection and analysis which has been carried out in the laboratory, stratigraphy study area was divided into 6 unofficial lithostratigraphy units and 2 litodem with the sequence of an old rock to young as follows: Halang volcanic breccia unit (Tmb), Halang sandstone unit (Tmbp), Kumbang andesite lava unit (Tma), Andesite intrusion (Tmi), Tapak volcanic breccia unit (Tpb), Tapak sandstone unit (Tpbp), Tapak limestone unit (Tpbg) and Alluvial (Qa).

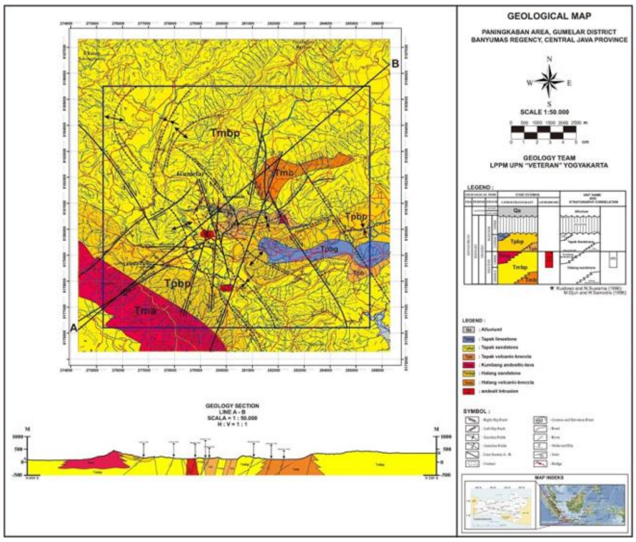

Figure 1. Paningkaban Area Geological Map, Gumelar District, Banyumas Regency, Central Java

ALTERATION AND MINERALIZATION

Alteration and mineralization process is an altering process in a rock on its chemical, physical, and others as a result of a process with hot solution media influence. In this case, the rock which is have been influenced or changed known as wallrock. While the process that happen on the wallrock known as wallrock alteration process, which is a chemical process that changes the original rock by hot flowing solution medium. After all, the most important aspects in the rock alteration and mineralization is the presence of fractures in the rock (channelway) which can be the path to discharge the hot solution to the surface and consequently interact with the wallrock, and the result is some new mineral deposits. The association of these new minerals is usually known as a type of alteration.

Rock lithology conditions in the research area are also included in the category in experiencing the process of alteration and minerallization, making the study area was being divided into three zones of alteration, namely: argillic zoning, propylitic zoning, and sub-propylitic zoning. This determination is based on the megascopic observation in the field using the helping tools such as loop and mineralography (poles). The alteration zones temperature range in the research area refer to the range of temperature and pH according according to Heru Sigit Purwanto**,** et all **(**2001).

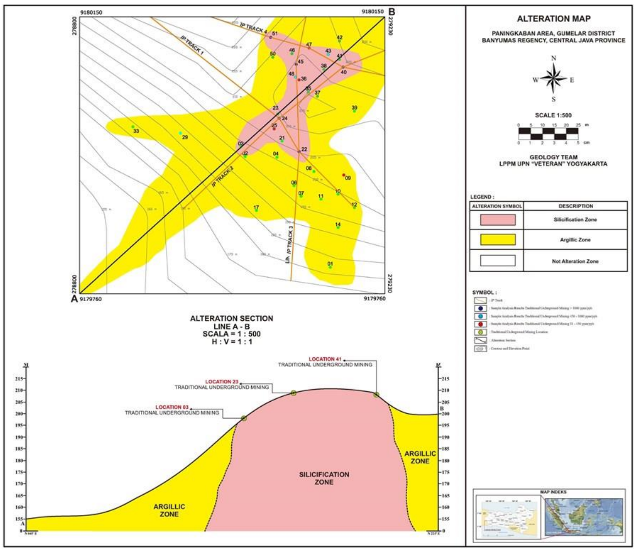

Figure 2. Alteration Map, Gumelar District, Banyumas Regency, Central Java

Argillic alteration

This alteration zones occupy ± 10% from the total of the research area and the relatively located at western part of the research area. This alteration zoning spread relatively trending southeast-northwest. This zoning is generally giving some impression of the grayish white to dark gray, milky until cream, and sometimes slightly reddish color. Possess hard-soft characteristic, sticky and fatty streak felt on the hand skin. This alteration is generally found in the Halang sandstone unit that cannot being identified the original form caused by the alteration and there is no trace of primary mineral in the wallrock body. This assumes that this type of alteration relatively change the rock with medium-strong intensity. This alteration type is also found in several places in conjunction with the quartz vein along with the sulfide minerals in a form of pyrite and chalcopyrite.

Megascopically on the field, the set of alteration minerals seen in outcrop location of this type of alteration in the research area is dominated by a set of clay minerals, which can be seen and felt through its texture, color and streak. The alteration minerals contained in these alteration zones include: kaolinite, illite, quartz, and chlorite. In addition, the presence of sulfide minerals are relatively occurring in this zone is in the form of pyrite and others. The observation point location of this type of alteration in the research area.

Figure 3. (a) The appearance of argillic alteration type outcrops on the location of the observations 9 (Coordinates: X: 278,872, Y: 9,179,848, elevation 160 m), (b) the appearance of a collection of dominance clay mineral, (c) quartz veins containing sulfide minerals such as pyrite, (d) quartz veins embedded in the body of rock that dominated by clay minerals. Direction of the image; outcrop N 160°E, parameter N 141°E.

Propylitic alteration

This alteration zones occupy ± 9% from the total of the research area and the relatively located at western part of the research area. This alteration zoning spread relatively trending southeast-northwest and in the outside of former argillic alteration zone. This zoning is generally giving some impression of strong greenish white, gray to green to blackish brown color. Possess hard-soft characteristic. This alteration is generally found in the Halang sandstone unit that cannot being identified the original form caused by the alteration and there is no trace of primary mineral in the wallrock body. This assumes that this type of alteration relatively change the rock with medium-strong intensity. This alteration type is also found in several places in conjunction with the quartz vein along with the sulfide minerals in a form of pyrite, chalcopyrite, galena, and bornite, this alteration semilar with at Tindikala-Boton Area (Daniel Herve Goret,et all,2013).

Megascopically on the field, the set of alteration minerals seen in outcrop location of this type of alteration in the research area is dominated by a set of minerals chlorite, calcite, kaolin, illite, quartz and clay-sized minerals, which can be seen and felt through its texture, color and streak. In addition, the presence of sulfide minerals are relatively occurring in this zone is in the form of pyrite and others. The observation point location of this type of alteration in the research area.

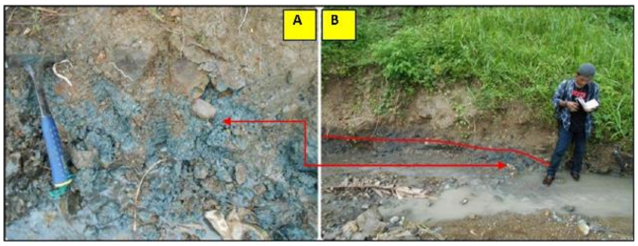

Figure 4. (a) The appearance of propylitic alteration type outcrops in the location of the observation 20 (Coordinates: X: 280,074, Y: 9,180,125, elevation 153 m), (b) the appearance of a collection of dark green chlorite minerals dominance, kaolin, quartz, and the montmorillonite mineral. Direction of the image; outcrop N 284°E, parameter N 254°E.

Sub-propylitic alteration

This alteration zones occupy ± 16% from the total of the research area and the relatively located at western part of the research area. This alteration zoning spread relatively trending southeast-northwest and in the outside of former propylitic alteration zone. This zoning is generally giving some impression of greenish gray, gray to light green and brownish color. Possess hard characteristic. This alteration is generally found in the Halang sandstone unit and can be identified its original. This assumes that this type of alteration relatively change the rock with weak intensity. This alteration type is also found in several places in conjunction with the quartz vein along with the calcite veins.

Megascopically on the field, the set of alteration minerals seen in outcrop location of this type of alteration in the research area is dominated by a set of minerals chlorite, kaolin, calcite, quartz, and clay-sized minerals (clay), which can be seen and felt through its texture, color and streak. In addition, the presence of sulfide minerals are relatively occurring in this zone is in the form of pyrite.

Figure 5. (a) The appearance of sub-propylitic alteration type outcrops on the location of the observation 13 (Coordinates: X: 279,666, Y: 9,180,616, elevation 148 m), (b) the appearance of sulfide minerals pyrite in quartz veins (quartz veins) and wallrock which has been altered and shows the chlorite minerals. Direction of the image; outcrop N 290°E, parameter N 315°E.

Mineralization in the Research Areas

Mineralization found in the research area is relatively associated to quartz veins (veins or veinlets) in the Halang sandstone unit, as well as on the intrusion body in the study area. Ore mineralization contained in research area such as sulfide minerals, such as: pyrite (FeS_2), chalcopyrite ($CuFeS_2$), galena (Pbs) and bornite (Cu_5FeS_4).

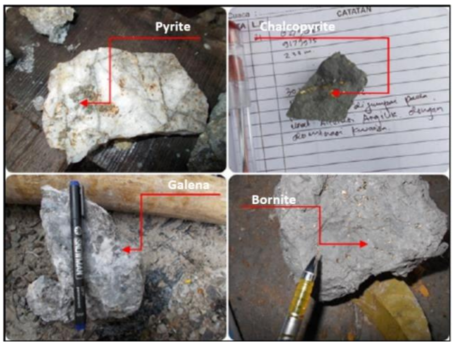

Figure 6. The photograph of sample collection in the research area, Paningkaban village, Gumelar District, Banyumas Regency, Central Java

STRUCTURAL GEOLOGY RESULTS AND ANALYSIS

Geological structures analysis is carried out in the megascopic and mesoscopic scale. Both analyses have an important role in the understanding and analysis of geological structures in all the research area, (Davis, B.K and Hippertt, J.F.M. 1998).

Macroscopic analysis performed by interpreting the straightness alignment in the SRTM topographic maps images. Straightness alignment data is then processed into the program named DIPS, making the a rosette diagram showing the direction of alignment obtained from the reflection of geological structure traces direction in the research area (Satellite image of tele atlas, 2012).

The straightness alignment data obtained from the SRTM image interpretation:

The general direction of the geological structure traces direction alignment in the research area, which is relatively trending N 305°E (northwest-southeast), and N 055°E (northeast-southwest) that supposed to be the traces of geological structures either fault or fold axis alignment.

Results of the analysis of AAS (Atomic Absorption Spectroscopy) or atomic absorption spectrophotometry is used to determine the content of sulfide mineral elements contained in a sample. The analysis shows increase in sulfide mineralization which is characterized by the abundance of the elements Cu, Pb, Zn, Ag, Au, some places elements of Au increases compared with other elements, this same with Jangglengan Area (Heru Sigit Purwanto, 2004).

NO	METODA/ (Method	AAS						
	KODE CONTO	Cu ppm	Cu %	Pb ppm	Zn ppm	Zn %	Ag* ppm	Au* ppb
1	AAS LP 47	14	-	15	59	-	2.3	5
2	AAS LP 11	-	5.81	26	91	-	16.4	47
3	AAS LP 7	1247	-	3060	-	1.02	1.7	50
4	AAS LP 2	243	-	18	95	-	1.6	23
5	AAS LP 1	-	3.36	181	641	-	9.9	447
6	AAS LP 12	5016	-	88	178	-	7.2	67
7	AAS LP 16	888	-	15	188	-	0.3	15

Catatan/ Note :
1 % = 10 000 ppm
1 ppm (gr/ton) = 1000 ppb
* = sudah terakreditasi

Table 1.1. The result of AAS analysis

CONCLUSION

1. Hydrothermal alteration which is formed in the research area is grouped into three types of alteration zoning named argillic alteration, propylitic alteration, and sub-propyllitic alteration.
2. Mineralization found in research area is pyrite (FeS_2), chalcopyrite ($CuFeS_2$), galena (Pbs), and bornite (Cu_5FeS_4).
3. Macroscopic structural analysis in the research area based on the direction of past geological structure traces alignment in the form of fault, fold axis lineament that relatively trending N 305°E (northwest-southeast).
4. In the research area, mineralization process is controlled by geological structures such as faults and fractures. An area where many abundant mineralizations found is fractures area especially shear fracture that generally trending northeast-southwest and northwest-southeast with the direction of fractures sharpness is measured relatively trending north-south.

5. Alteration and mineralization found in the surrounding Sadahayu village as well as in the Paningkaban village. Areas with lithological interaction between igneous and breccia deposits potentially have a feature as a gold carrier deposit.

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REFERENCES

1. Asikin S., Handoyo A., B. Pratistho, and Gafoer S., 1992, *Banyumas Regional Geological Map Sheet* (1308-3), the Centre for Geological Research and Development, Directorate of Geology.
2. Condon WH, Pardyanto L., Ketner KB, Amin TC, Gafoer S., and Samodra H., 1996, *Map Sheet Banjarnegara-Pekalongan geological Regional* (1408-2, 1407-5), Geological Research and Development Centre, Directorate of Geology.
3. Daniel Herve Goret, Theophile Ndougsa, Arsene Maying, Stephane Patrick Assembe, Alpnonese Didior, Man-Mvele Pepogo (2013). Gold mineralization channels indentification in the Tindikala-Boton Area (Eastern-Cameroon) using geoelectrical (DC&IP) methods: a case study. *International Journal of Geosciences, 2013,4,643-655.*
4. Davis, B.K and Hippertt, J.F.M. 1998. Relationships between gold concentration and structure in quartz veins from the Hodgkinson Province, Northeastern Australia. *Mineralium Deposita* 33: 391-405.
5. Heru Sigit Purwanto, Ibrahim Abdullah & Wan Fuad Wan Hassan. 2001. Structural control of gold mineralization in Lubok Mandi area, Peninsular Malaysia. *International Geoscience Journal, Special Issue on Rodinia,Gondwana and Asia* 4(4) :742-743.
6. Heru Sigit Purwanto**.** 2004. Structural Control of Gold Mineralization in Jangglengan Wonogiri, Central Java, Indonesia. *Proceeding of 32nd International Geological Congress, Florence, Italy, August, 20-28, 2004.*
7. Kastowo, 1975, *Map Sheet Majenang Regional Geology* (10 / XIV-B), the Centre for Geological Research and Development, Directorate of Geology.
8. Nikolay A.Goryachev & Franco Pirajno.(2014). Gold deposits and gold metallogeny for east Russia, journal Oregeorev, vol.59: June 2014.
9. Sanzhong Li, M.Santosh, Borming Jahn.2012. Evolution of the Asian Continent Margins, Journal of Asian Earth Sciences, Vol 47 .2012
10. Satellite image of tele atlas, 2012, Image Image Google Earth, US Navi, NGA, GEBCO.