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Au Grade of Epithermal Gold Ore at Paningkaban ASGM, Banyumas District, Central Java Province, Indonesia

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Abstract— There are many Artisanal Small scales Gold Mine (ASGM) in Indonesia, one of them is epithermal gold ore at Paningkaban, Banyumas District, Central Java Province. The activity has been for about twenty years. The existence of ASGM at Paningkaban still takes place until now. It can be an indicator that they are still many gold resources. The aim of the research is the analysis of Au grade and other metal, such as Cu, Ag, Pb, As, Zn and Hg. The research methods are literature study from previous research, field work, laboratory work, and interpretation. The literature study comes from previous research at the location. The field work comprised direct observation and taking the sample of gold ore/vein in the location of research. Fieldwork is done for a week to obtain gold ore/ vein. The sixteenth samples were analyzed to obtain ore/metal grades. The fifth of the highest Au grade were conducted Hg laboratory analysis. Laboratory works conducted at Intertek Jakarta using Fire Assay (FA) for Au grade, Atomic Absorption Spectrophotometry (AAS) for Cu, Ag, Pb, As, Zn and Hg. Results of the analysis were variety wide range grade of Au, i.e. 0.266 – 76 ppm. The wide range grade of Cu is 42-1230 ppm, 30- >4000 ppm of Pb, 74->10,000 ppm of Zn, <1-34 ppm of Ag, <40-550 ppm of As, and <0.01-0.16 ppm, respectively.

Keywords— ASGM, epithermal, gold, grade, Paningkaban

INTRODUCTION

The research location, Paningkaban, is one of the gold mineralization at Banyumas District, Central Java Province, Indonesia (Fig.1). Mining activities is conducted by ASGM or local community surrounding mining location. These activities have done for around twenty years. The mining community use a vertical tunnel method (shaft) to obtain gold ore/vein with simply apparatus, such as rope and torch in head. Strength of tunnel use wooden blocks comprised followed tunnel depth. Air ventilation for people in the tunnel flows from surface with pipe diesel machine (Fig.2). They work usually at 8 am to 3 pm, after that they do mineral processing with mercury, called amalgamation process. The gold ore is crushed with hammer become around 2 cm and then it is milled for 6-8 hours.

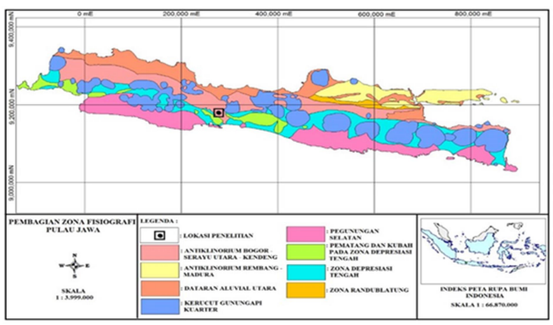

Fig.1. Map location the research

Fig.2. Vertical Tunnel (Shaft) at ASGM

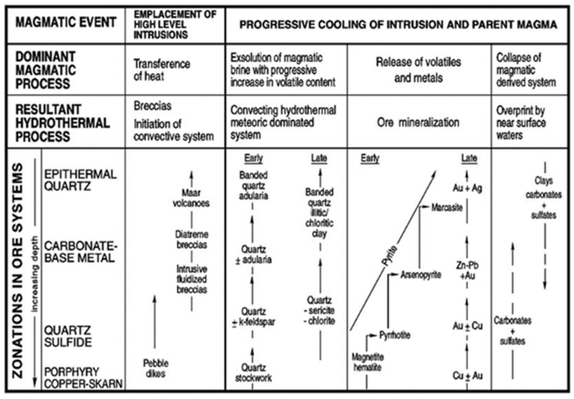

Fig.3. Spatial zonation of LS epithermal gold [2]

Au mineralization of LS epithermal

LS epithermal formed near neutral pH with the fluids temperatures of 200^0-300^0 C which dominated by meteoric waters, although magmatic gases maybe be present, mainly CO_2, SO_2 and HCl. There are Au-rich and Ag-rich system. Au-rich system has base metal poor, low salinity (1-2 wt% NaCl equivalent), gas rich fluid (CO_2 and H_2S mainly), Ag/Au ratio range from 1 to 10. Otherwise with Ag-rich system, it has high salinity (10-15 wt% NaCl equivalent), high Ag/Ag ratio (>100), and contain associated base metals [1].

Reference [2] divided LS epithermal Au into three groups, i.e. quartz-sulphide Au±Cu, carbonate base-metal Au, and epithermal quartz Au±Ag (Fig.3). Characteristic of quartz-sulphide Au±Cu is typically quartz with auriferous pyrite such as chalcopyrite, pyrrhotite and haematite at deeper crustal level high temperature condition but at shallow crustal level low temperature condition is marcasite, opal and "grey silica". Au grade commonly is < 2 g/t. Gold is generally high fineness with typical Ag:Au > 1. Carbonate base-metal Au is early pyrite±quartz (of quartz-sulphide stage) followed by sphalerite>galena and local chalcopyrite or Ag sulphosalts followed by variable carbonate, but dominated by Mn carbonate (typically rhodochrosite) and locally quartz added. Epithermal quartz Au±Ag is characterized by gangue poor, high fineness, free Au which commonly overprints quartz-sulphide or carbonate base metal Au ore systems.

Ore characteristic typically of LS epithermal gold (adularia-sericite epithermal deposit) is a dominant open space vein, stockwork ore common, replacement ore minor and disseminated ore mostly minor [3]. Generally typical ore of LS epithermal carbonate base metal Au style is as stockwork fracture, dissemination, sheeted vein, breccia matrix, fissure vein, phreatomagmatic (diatreme) breccias, deeper level magmatic hydrothermal breccias or

domes [4]. The texture of LS epithermal gold is colloform and crustiform. The associated mineral is stibnite, cinnabar, adularia, and metal sulfide. The ore mineral is pyrite, electrum, gold, sphalerite, and arsenopyrite [5].

Associated alteration of adularia-sericite epithermal (LS epithermal) is sericite-illite/sericite-adularia, silicification, outward prophylitic alteration. Metal association of it, i.e. Au, Ag, As, Sb, Hg±Pb, Zn, Te with Au:Ag=1:10 to 1:25 and base metal rich is Zn, Pb, Cu. Grade of deposits is 2-70 g/t.Au [6].

Gold ore in the location is a carbonate-base metal gold mineralization sub-type of a low sulphidation (LS) epithermal system. There are four main alteration zones in Paningkaban, i.e. phyllic alteration, argillic alteration, sub-propylitic alteration and weak sub-propylitic alteration. Gold-bearing veins associated with argillic and weak sub-propylitic alteration type. The textures at Paningkaban are normal banded, cockade, crustiform, bladed carbonate, comb and saccharoidal. All of them are composed of carbonate with minor quartz and adularia [7].

RESEARCH METHODS

The research methods are literature study from previous research, field work, laboratory work, and interpretation. The literature study comes from previous research at the location. The field work comprised direct observation and taking the sample of gold ore/vein in the location of the research. Fieldwork is done for a week to obtain gold ore/ vein. The sixteen samples from different sixteen shaft were analyzed to obtain ore/metal grades. Laboratory works conducted at Intertek Jakarta using Fire Assay (FA) for Au grade, and Atomic Absorption Spectrophotometry (AAS) for Cu, Ag, Pb, As, Zn and Hg grade. The fifth of the highest Au grade were conducted Hg laboratory analysis.

RESULTS AND DISCUSSION

Result of analysis shows that Au grade at Paningkaban has wide range value from 0,266 ppm to 76 ppm (detection limit 0.005 ppm). There are five samples having more than 10 ppm, i.e. P1, P3, P4, P5 and P22 (Table 1). Au grade of P3 has the highest value that is >50 ppm, so it is to know the value of P3 Au grade using detection limit 3 ppm and it is obtained 76 ppm. Reference [6] declare that adularia-sericite epithermal has generally having grade deposit of 2-70 g/t Au.

Ag grade of gold ore is <1 ppm to 34 ppm (detection limit 1 ppm). Ag/Au ratio for the fifth highest of Au grade has 1:2 to 1:4, but the others have various value. Some samples have Ag grade more than Au grade such as P7, P9, P13, P20, P23 and P28 (Fig.4). Half of samples have Ag/Au ratio 1:1 to 1:4 and Ag content more than 20%, it indicated that gold ore formed as native gold or electrum.

Cu grade of gold ore is 42 ppm to1230 ppm (detection limit 2 ppm). That value is high grade which shows LS epithermal with base metal rich (Pb, Zn and Cu) [6]. It is indicated that associated mineral of half samples is chalcopyrite. In Fig.7 shows that P13 is the highest grade of Cu, 1230 ppm.

Pb grade of gold ore is 30 ppm - >4000 ppm (detection limit 4 ppm) or 30 ppm to 14,200 ppm (detection limit 0.01%). The Pb grade has wide range grade. There are four samples having high grade of Pb, i.e. P3, P5, P13 and P28. The highest is P13, 14,200 ppm [Fig.5]. Most of samples have high Pb grade more than 300 ppm, it indicates that Au mineralization associated mineral as galena.

Zn grade of gold ore is 74 ppm to >10,000 ppm (detection limit 2 ppm) or 74 ppm to 26,300 ppm (detection limit 0.01%). It shows wide range Zn grade. The same with Pb, there are four samples having high grade of Zn, i.e. P3, P5, P13 and P28. The highest grade is P3, 26,300 ppm [Fig 6]. The high Zn grade indicated associated mineral as sphalerite and characteristic of adularia-sericite epithermal (LS epithermal) which having base metal rich (Pb, Zn and Cu)[6].

As grade of gold ore is < 40 ppm to 550 ppm (detection limit 40 ppm). The most of samples have high grade of As and the highest is P20, 550 ppm [Fig.8]. The high As grade is indicated derived from arsenopyrite mineral.

Hg grade conducted of the fifth highest Au grade, i.e. P1, P3, P4, P5 and P22. Hg grade is <0.01 ppm to 0.16 ppm (Fig.9). This value is very low. The value Hg grade is needed to know how effect Hg of gold ore to water contaminant. Water contaminant from amalgamation process flow away through stream around the location research.

Table 1. Au and other metal content from ASGM at paningkaban

Ident	Au	Au	Ag	Pb	Pb	Zn	Zn	Cu	As	Hg
Units	ppm	ppm	ppm	Ppm	%	ppm	%	ppm	ppm	Ppm
Detection limit	0.005	3	1	4	0.01	2	0.01	2	40	0.01
P1	19.6		12	1,690		6120		655	240	0.08
P2	0.266		<1	300		125		57	<40	
P3	>50	76	34	>4,000	1.17	>10000	2.63	285	360	< 0.01
P4	25.3		6	2,150		1480		29	290	< 0.01
P5	42.5		20	>4,000	0.8	>10000	1.16	490	160	0.01
P7	1.8		10	1,620		1670		273	100	
P9	0.265		2	30		74		42	60	
P13	5.54		26	>4,000	1.42	>10000	2.15	1230	300	
P14	6.03		4	675		663		87	60	
P19	4.16		3	1,690		1550		42	160	
P20	1.34		3	767		879		101	550	
P22	10.7		7	2,010		3920		262	310	0.16
P23	0.596		3	97		306		343	300	
P27	9.14		5	1,720		1300		145	100	
P28	6.49		19	>4,000	0.87	>10000	1.4	668	350	

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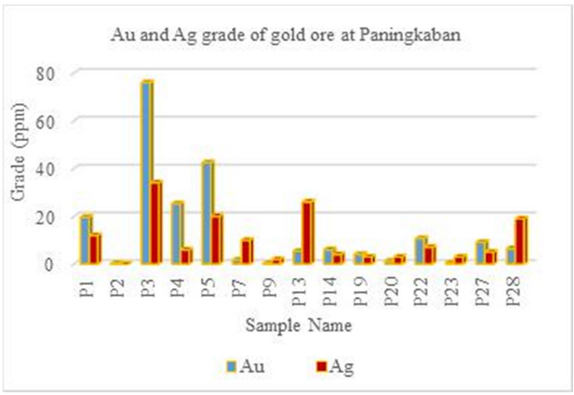

Fig.4. Au and Ag grade Chart of gold ore at Paningkaban

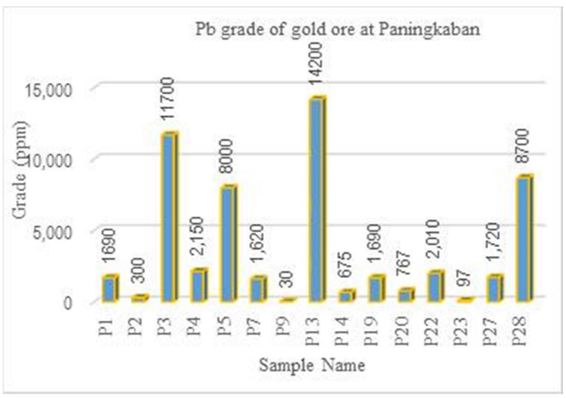

Fig.5. Pb grade Chart of gold ore at Paningkaban

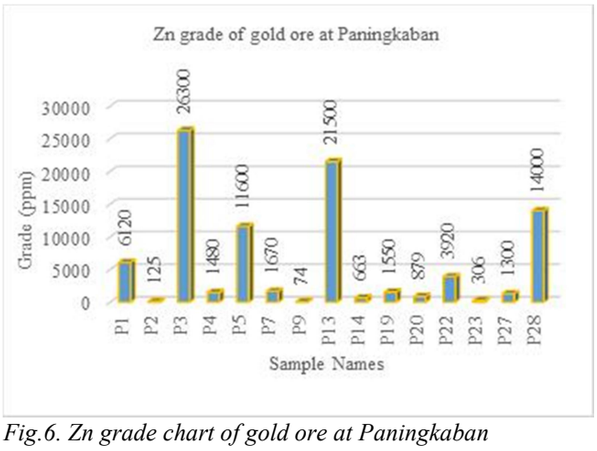

Fig.6. Zn grade chart of gold ore at Paningkaban

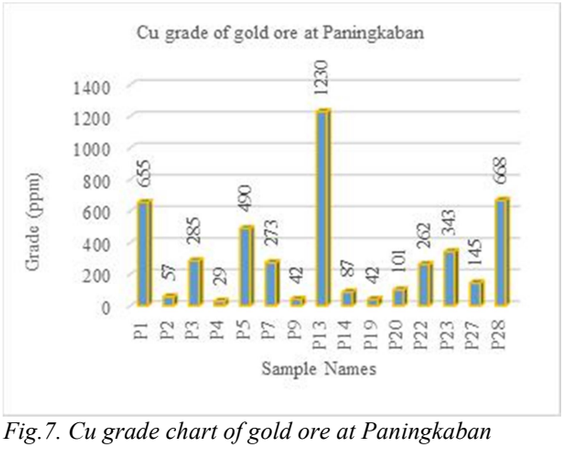

Fig.7. Cu grade chart of gold ore at Paningkaban

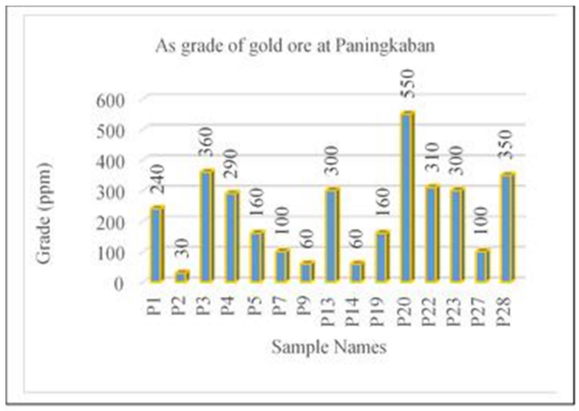

Fig.8. As grade chart of gold ore at Paningkaban

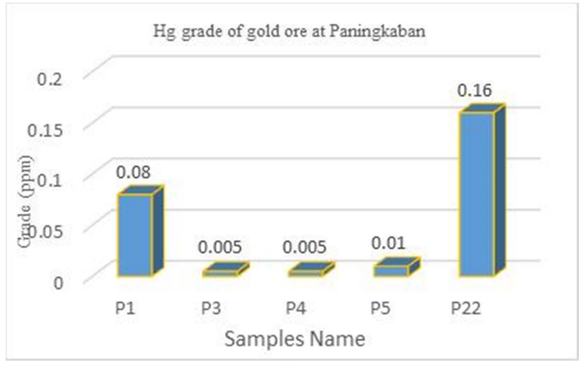

Fig.9. Hg grade chart of gold ore at Paningkaban

CONCLUSION

Au mineralization formed as native gold or electrum because of Au/Ag ratio 2:1 to 4:1 and Ag content more than 20%. Associated mineral of the samples in the location research indicate galena, sphalerite, and chalcopyrite which show characteristic of base metal rich Pb, Zn and Cu at LS epithermal. Au content of five samples and almost half of samples is high grade with Au grade more than Ag grade. It shows that Au gold ore at Paningkaban still economic to mine for ASGM, furthermore the vein can be conducted extraction for obtained other metal such as Cu, Pb, Zn and As because they have high grade if there is technology for it.

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REFERENCES

[1] Pirajno, F., 2009, *Hydrothermal Process and Mineral Systems*, Springer, pp.434-440.

[2] Corbett, G.J. and Leach, T.M., 1998, Southwest Pacific-Rim Gold-Copper Systems : Structure, Alteration, and Mineralization, *Society of Economic Geologists Special Publication number 6*, pp. 69-94 and 137-200.

[3] White, N.C., and Hedenquist, J.W., 1995, Epithermal Gold Deposits: Styles, Characteristics and Exploration, Published in SEG Newsletters, 1995, No.23, p. 1, 9-13.

[4] Corbett, G., 2013, Pacific Rim Epithermal Au-Ag, *World Gold Conference, Australian Institute of Mining and Metallurgy*, 26-27 September 2013.

[5] Leach, T.M. and Corbett, G.J., 1995, "Characteristic of Low Sulfidation Gold-Copper Systems in The Southwest Pacific", *In Pacific Rim Congress 95, 19-22 November 1995, Auckland, New Zealand,*

proceedings: Carlton South, The Australian Institute Of Mining And Metallurgy, pp.327-332

[6] Robert,F.,Poulsen,K.H., and Dube, B., 1997, Gold Deposits and Their Geological Classification, Proceedings of Exploration 97 : Fourth Decennial International Conference on Mineral Exploration, pp.209-220.

[7] Idrus A., Hakim F., Warmada W., Aziz M., Kolb J., Meyer F.M., 2015, Geology and Ore Mineralization of Tertiary Sedimentary Rock Hosted LS Epithermal Gold Deposit at Paningkaban, Banyumas District, Central Java, Indonesia, *Proceedings Vol 1, 13th SGA Biennial Meeting Mineral Resources in A Sustainable World, Nancy-France*, pp. 299-302.