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Type of Gold Hydrothermal Deposits on Metamorphic Rock District Buru, Province Maluku

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ABSTRACT

An investigation on gold occurrence in Buru island is needed to determine type of deposit in the area. This study aims to analyse mineralisation, alteration and metamorphic facies of metamorphic-hosted gold deposit in Buru area by using petrographic method, x-ray flourescense, x-ray diffraction, and polish section. The results reveral that there are two types of metamorphic rocks: schists and phyllite. Greenschist facies are charecterized by muscovite mineral, quartz, chlorite, biotite, clay mineral, and codierite. Phyllite is in the same genetic condition with schist (medium metamorphism), with formation temperature ranges from 300°C to 450°C with a pressure around 1-8 Kbar through a regional metamorphism process. Alteration in quartz veins indicated the nature of proximal zone to ore zone. Silicic alteration (quartz) is also found intensely, and it is generally associated by propylitic alteration (chlorite) and sericitic (muscovite). Mineralisation follows the direction of the distribution of quartz veins with crustiform banding texture. The quartz vein thickness is from 40 cm to 50 cm. The alteration and mineralisation occurrence of the studied area suggests epithermal gold deposits type.

Keywords: Buru island, metamorphic rocks, gold deposit, epithermal.

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1. INTRODUCTION

Buru Island is characterized by the occurrence of terrane consists of low grade metamorphics of greenschist facies to medium grade metamorphics of amphibolite facies. Their ages are Paleozoic and consist of micaschist, phyllite, slate, metasandstone and marble. Their composition seems to reflect an origin as flysch type sediments (Fig 1.). Further, the terrane consists of flysch type Triassic sediments (Dalan Formation) and dolomite reef limestones (Ghegan Formation). The terrane is overlain by Jurassic-Eocene deep-sea deposits consisting of calcilutite, shale and marl and Oligocene-Pliocene shallow-sea deposits. At the base, conglomerate and basic pillow lava are found [1].

It has been reported that the metamorphic terrane hosted some gold mineralization [2, 3, 4] indicated by segmented, sigmoidal and discontinuous quartz veins which in line to foliation of metamorphic host rock, especially mica schist. The quartz veins with gold generally show colloform banded,

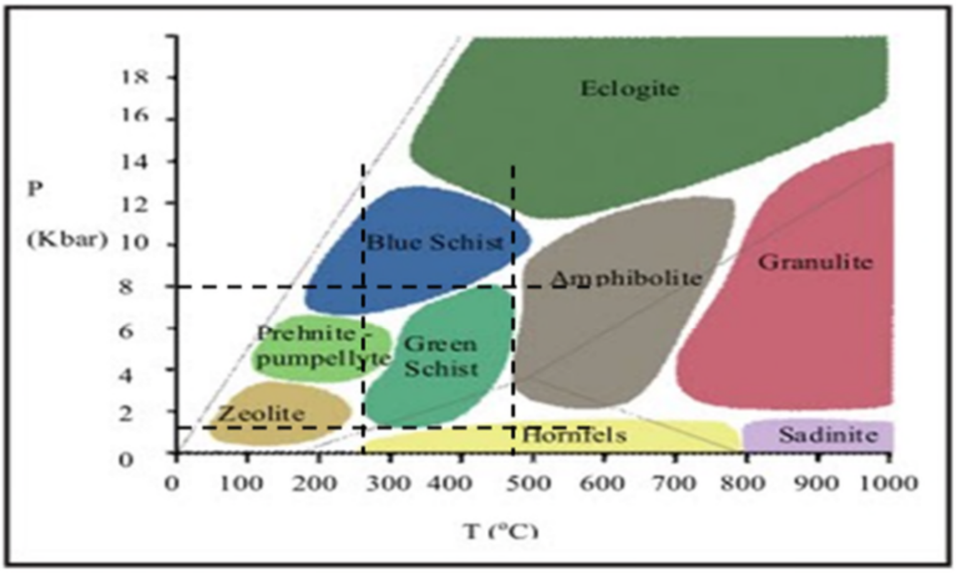

Fig 1. Metamorphic facies classification [5].

sulphide banding, brecciated and bladed-like texture. Orientation trend of alteration distribution in hydrothermal deposit in Buru Island [6]. There are some genetic differences of mineralization in volcanic, metamorf, metasedimentary and limestone.

One of the places in which gold deposit found is Gunung Botak. Study on gold occurences in this place has been conducted by several workers, but detail analyses on deposit type in metamorphic rocks especially schist has never been done. This study reports the hydrothermal deposit type on metamorphic rocks, particulalrly schist in Buru Island based on detail description on texture, alteration and ore mineralization style.

2. MATERIALS AND METHODS.

Petrographic analyses was conducted to determine rock type, texture and mineral composition of host rocks using polarizing microscope. XRD (*X-ray Diffractions*) analyses was used to determine altered mineral while XRF (*X-Ray Fluoresence*) analyses was used to determine major elements of host rock. Gold content was analysed by *atomic absorpsion spectrometry* (AAS).

3. RESULTS AND DISCUSSION

A. Lithology

Lithology of studied area consists of two metamorphic rocks: muscovite schist and phyllite. Muscovite schist shows light grey in color indicating chlorite alteration. Quartz vein banding generally cut the foliation but sometime in line with foliation (N20^{o}E) and dip 16^o south-southeast. Optically, muscovite schist was characterized by schistose. Mineral composition composed of muscovite (25%-

35%), quartz (15%-25%), chlorite (5%), biotite (10%) small amount of clay, cordierite and opaque mineral.

Phyllite showing foliated texture, consists of quartz, biotite and clay mineral, dark grey to blackish, sometimes greenish indicating chloritization alteration. Phyllite in Gunung Botak occur as host rock, containing quartz vein pararel to foliation (N185°E/37°).

B. Hydrothermal alteration and mineralization

Mineralization proccess in Gunung Botak is characterized by vein quartz, showing white –brownish to reddish due to oxidation, contain fine-grained pyrite (FeS_2) associated with silica mineral. Other ore mineral are hematite (Fe_2O_3), pyrite (FeS_2) and gold (Au) (Fig. 2). Hematite (Fe_2O_3) showing grey metallic, anisotropic, present to fill fracture in rocks. Pyrite (FeS_2) showing pale yellow with high relief and relatively fined-grained occur as filling rock fracture associated with gold (Au). Stockwork and gangue mineral occurs in the studied area (Fig. 3).

C. Rock geochemistry

Vein quartz samples were collected from studied area and analyzed by XRF to determine major oxide while trace element were analyzed by ICP-OES and gold determination (Au) was analyzed by AAS (fire assay) method. Results of analyses are depicted in Table 1. Correlation of Ag and Pb is shown in Fig. 4.

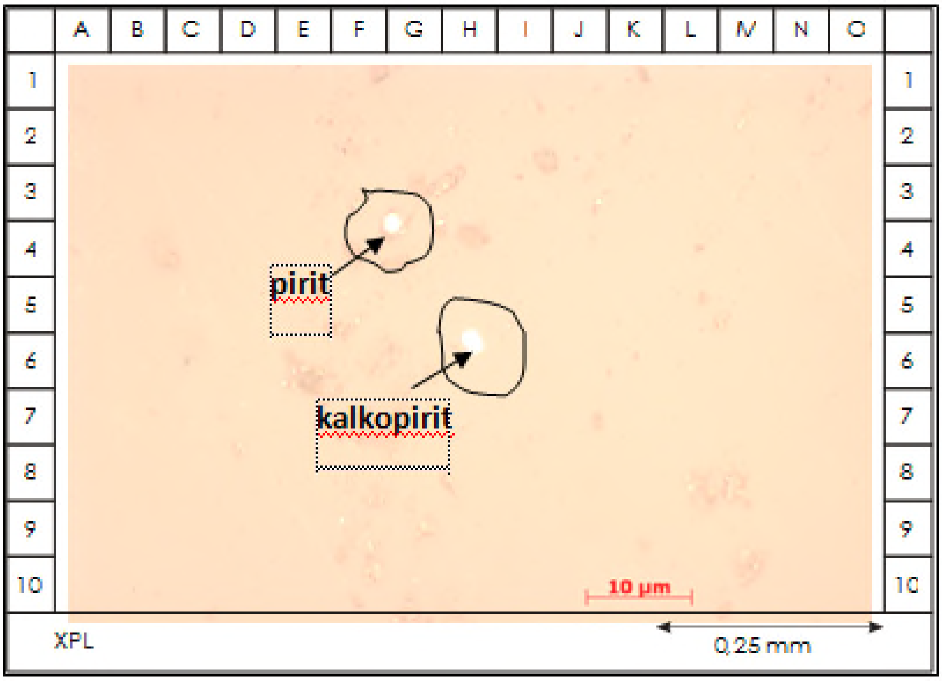

Figure 2. Microphotograph of pyrite (G4), and chalcopyrite (H6).

D. Gold Hydrothermal Deposits

Based on field and petrographic data, the occurrence of muscovite, quartz, chlorite, biotite, clay mineral, cordierite suggest greenschist facies. Temperature ranges from 250-450^{o}C and pressure ranges from 1-8 Kbar formed by regional metamorphism. Study result show proximal zonation to ore zone, indicated by intensive silisic alteration associated with prophylitic (chlorite) and sericitic (muscovite). XRD result from two samples (GB 05 and GB 07) show quartz dominated indicating silisic alteration dominated by clay mineral and abundant distribution of opaque minerals. This suggests that temperature difference causes overprint between argillic (supported by clay minerals) and silisic alteration.

Generally, mineralization occurs in quartz vein outcrop. Vein quartz shows crustiform banding with thickness from 40-50 cm.

Vein quartz thickness range from 3 to 10 cm which consists of interlayering between non-sulphide vein quartz banding and sulphide mineralization. On the other site of shaft, irreguler cross cutting veinlets occur forming stockwork. Mineralization zone is surrounded by propillitic alteration (green in color), argillic and sericite (clay mineral, grey to greenish) and silisic. The occurrence of fluid inclusion and silicate mineral can be taken as an indication a quart vein Au-Cu ore deposit mineralization system. Geochemical data showed that Au content from 7 anaylsed samples tange from 0.23 to 5.9 ppm (gr/ton).

Significant gold content found in sampple GB.09 (1.83 ppm). However, gold content show a negative correlation silver (Ag) content and base metal (Cu,Pb and Zn). Ag and base metal content are very low and most of them aer below detection limit based on XRF (less than 1 ppm). As and Sb content in analyses samples generally show a significant

Fig. 3. Stockwork vein and *gangue* mineralization

value (228 ppm and 33 ppm, respectively). This suggests that mineralization in the studied area is non-polymetallic mineralization or gold mineralization without silver and base metal mineralization [7].

Based on these, it was concluded that mineralization in the studied area can be concluded as hydrothermal deposit. Mineralization is hosted by greenschist-facies metamorphic rock. Alteration mineral associated with this mineralization is chlorite formed within temperature range of 200-300^{o}C [8]. Ore mineralization in quartz found in the form of vein, indicating epithermal-hydrotermal type deposit [9].

Ag content. Similar trend is also shown by correlation diagram of Au and base metal. However, Au and Cu showed somewhat positive correlation trend. Based on trace element and associated metal shown by geochemical data, it can be assumed that mineralization in the studied area is epithermal high sulphidation [8].

4. CONCLUSIONS

Based on this study, it is concluded that alteration in quartz vein Din schist showed proximal zonation to the ore. Silicic alteration was also found intensively associated with

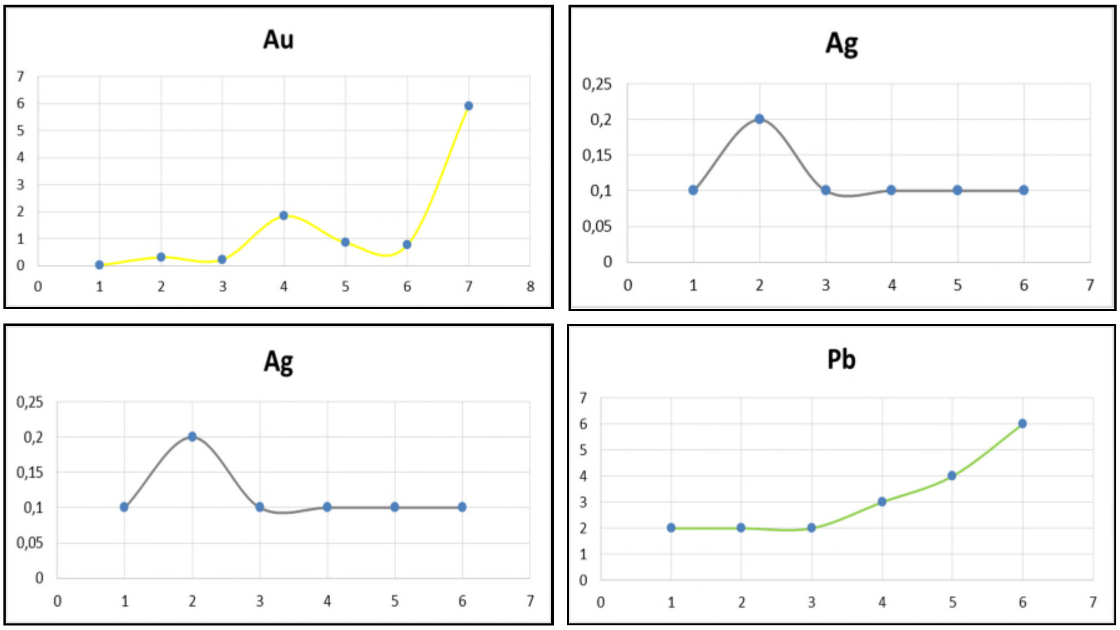

Fig. 4. Plot of Au, Ag and Ag, Pb elements.

Geochemical plot show negative correlation trend of Au and Ag, represented by stable value of Ag (0.1) with increasing of Au and stable Au content (0.23) with increasing

propilitic alteration (chlorite) and sericite alteration (muscovite). The mineralization in metamorphic rocks in line with quart vein with crustiform banding texture distibution trend, showing a thickness of 40 to 50 cm. Alteration and mineralization type indicated that gold deposit occur as epithermal gold deposit.

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Table 1. Geochemical result (XRF, AAS, ICP-OES)

No. Stasiun	ST.04	ST.06	ST.08	ST.09	ST.10	ST.11	ST.11	
No. Sampel	GB.04	GB.06	GB.08	GB.09	GB.10	GB.11.A	GB.11.B	*DL*
Tipe sampel	*Float qz*	*Vein qz*	*Vein*	*Vein*	*Vein*	*Vein*	*Ore vein*	
Major oxides (wt.%)								
SiO_2	97,43	96,71	82,84	79,66	82,72	74,15	*NA*	0,01
TiO_2	<0,01	0,02	0,49	0,47	0,42	0,75	*NA*	0,01
Al_2O_3	0,04	0,24	10,49	11,62	9,49	15,72	*NA*	0,01
Fe_2O_3	2,61	2,65	1,43	2,37	1,87	1,74	*NA*	0,01
MnO	0,026	0,021	0,010	0,005	0,006	0,005	*NA*	0,005
MgO	<0,01	<0,01	0,15	0,22	0,27	0,27	*NA*	0,01
CaO	0,02	<0,01	0,01	<0,01	0,02	0,01	*NA*	0,01
Na_2O	<0,01	<0,01	0,06	0,1	0,08	0,16	*NA*	0,01
K_2O	0,01	0,03	0,94	1,52	1,64	2,32	*NA*	0,01
P_2O_5	0,01	0,01	0,014	0,012	0,015	0,018	*NA*	0,001
Cr_2O_3	<0,05	<0,05	0,036	0,044	0,028	0,011	*NA*	0,005
LOI	-0,7	-0,6	3,4	3,4	2,8	4,2	*NA*	0,1
S	<0,002	<0,002	0,006	<0,002	<0,002	0,003	*NA*	0,002
Trace elements (ppm)								
Au	<0,01	0,31	0,23	1,83	0,85	0,76	5,9	0,01
Ag	<0,1	0,2	<0,1	0,1	<0,1	<0,1	*NA*	0,1
Al	0,02	0,04	1,19	1,25	0,56	1,02	*NA*	0,01
As	<2	51	92	228	191	153	*NA*	2
Ba	1	2	21	36	29	38	*NA*	1
Bi	<2	<2	<2	<2	<2	<2	*NA*	2
Ca	0,01	<0,01	<0,01	<0,01	<0,01	<0,01	*NA*	0,01
Cd	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	*NA*	0,2
Co	2	2	1	2	1	1	*NA*	1
Cr	18	16	15	15	7	11	*NA*	1
Cu	2	2	13	35	16	18	*NA*	1
Fe	1,79	1,87	0,83	1,66	1,3	1,02	*NA*	0,01
Ga	2	2	3	4	3	4	*NA*	2
K	<0,01	0,01	0,1	0,2	0,15	0,22	*NA*	0,01
La	<1	<1	4	4	10	21	*NA*	1
Li	<1	<1	1	2	1	1	*NA*	1
Mg	0,01	<0,01	0,01	0,02	0,01	0,02	*NA*	0,01
Mn	182	159	16	22	8	10	*NA*	1
Mo	1	<1	<1	1	<1	1	*NA*	1
Na	0,01	<0,01	0,01	0,01	0,01	0,01	*NA*	0,01
Nb	<1	<1	<1	<1	<1	<1	*NA*	1
Ni	4	3	1	1	<1	<1	*NA*	1
Pb	<2	<2	2	3	4	6	*NA*	2
Sb	1	9	20	26	33	26	*NA*	1
Sc	<1	<1	3	3	2	5	*NA*	1
Se	<10	<10	<10	<10	<10	<10	*NA*	10
Sn	<5	<5	<5	<5	<5	<5	*NA*	5
Sr	1	<1	3	4	3	7	*NA*	1
Ta	<5	<5	<5	<5	<5	<5	*NA*	5
Te	<5	<5	<5	<5	<5	<5	*NA*	5
Ti	<0,01	<0,01	0,01	<0,01	<0,01	<0,01	*NA*	0,01