http://journal.uir.ac.id/index.php/JGEET

E-ISSN : 2541-5794
P-ISSN : 2503-216X

Journal of Geoscience,
Engineering, Environment, and Technology
Vol 7 No 4 2022

RESEARCH ARTICLE

Characteristics and Potential of Placer Gold Deposit in Lakan Bilem Block, West Kutai District, East Kalimantan, Indonesia

Arifudin Idrus [1]*, Ni'matul Azizah Raharjanti[2], Sufriadin[3]

[1] *Department of Geological Engineering, Universitas Gadjah Mada, Yogyakarta, Indonesia.*
[2] *Undergraduate Progam of Geological Engineering, Universitas Muhammadiyah Kalimantan Timur, Indonesia.*
[3] *Department of Engineering, Universitas Hasanuddin, Indonesia*

* Corresponding author : arifidrus@ugm.ac.id
Tel.:+62-274-513668; fax: +62-274-513668
Received: Oct 23, 2022; Accepted: Dec 7, 2022.
DOI: 10.25299/jgeet.2022.7.4.10772

Abstract

Kalimantan is recognized as one of Indonesian islands with huge prospect of minerals particularly gold both primary and secondary deposit styles. However, the publication of the gold resources is still restricted to be described in regional/district scale maps or exploration company internal reports, hence, a detailed study on deposit scale remains limited. This study is aimed to document the characteristics and the estimation of potential or resources of the secondary (placer) gold deposit in Lakan Bilem block, West Kutai district, East Kalimantan province, Indonesia. The study was done by field observation followed by microscopic analysis and simple resources estimation of the gold. Gold in the study area occur in the semi-consolidated paleo alluvial deposit as trace mineral. The gold morphologies show platy to angular form with coarse surface which indicates the process of gold deposition is predominantly controlled by hydrodynamic transportation at a relatively moderate regime. Estimation of the indicated resources of gold results a total of 4.96 tonnes of gold potentially occurred in the study area. Exploration drilling with 100 spacing grid is suggested to delineate lateral and vertical distribution of the gold deposit. The drilling also will upgrade confidence level of the resources from indicated to measured resources.

Keywords: Placer Gold Deposit, Gold Characteristics, Resources Estimation, Lakan Bilem Block, Kalimantan

1. Introduction

Kalimantan or Borneo Island is located in the continental margin of Eurasia plate which is known to be host of petroleum and coal resources. Kalimantan is also recognized as the island with huge mineral resources and prospects, especially gold. Gold Prospect in Kalimantan Island is hosted by Tertiary volcanic belt which elongated from western Kalimantan to the east – northeast identified as central Borneo gold belt. Gold deposits occur either as primary or secondary types. Moreover, base metal and other metal deposits also occur along the belt (Figure 1). The study area is located in Lakan Bilem block, Nyuatan sub-district, West Kutai district, East Kalimantan province which is identified as secondary or placer gold prospect. This area has been explored by many companies including a national private mining company, i.e. PT. Nugraha Insan Kencana Mining (PT. NIKM) (NIKM, 2013). The prospect is situated in the eastern part of Central Borneo Gold Belt (Harahap et al., 2013; Setijadji et al., 2010; van Leeuwen, 2018) (Figure 1).

The study area is also located near the two major productive gold mining namely Gunung Muro and Kelian which identified as primary gold epithermal deposits (van Leeuwen, 2015). Another mineral deposit potentials identified near the study area are Beruang Kanan and Busang (Anjarwati et al., 2019; Hackman, 2015; Slater et al., 2020). In Kalimantan, secondary/ placer gold deposits are found in many places such as Ampalit, Cempaga in Kasongan district (Seeley and Senden, 1994), Mempawah in west Kalimantan (Seeley and Senden, 1994; van Leeuwen, 2018), and the study area. The geological information about this study area is only available in form of regional data and company exploration report. The report is based on ground survey data. Hence, there are no publications on the characteristics and potential of the placer gold prospect in the study area. This study, therefore, is aimed to document the characteristics and the estimation of potential or resources of the placer gold in study area as the fundamentals for more detailed and advanced gold exploration in the region.

2. Regional Geology

Gold mineralization at the Lakan Bilem block, Nyuatan sub-district, West Kutai district is hosted by Tertiary sedimentary rock that deposited in Kutai Basin. According to the topography characteristics, the Kutai Basin is divided into two sub-basins namely upper Kutai basin and lower Kutai Basin, and the location of the study area is included in upper Kutai Basin (Chambers et al., 2004; Supriatna et al., 1995; Winarno et al., 2019) (Figure 2). The Kutai Basin covers almost all the area in East Kalimantan with the sediment supply from the central part of the Kalimantan Island. This indicates that the central part of Kalimantan was intensively uplifted and eroded during the Tertiary Period (Supriatna et al., 1995). Regionally, the sedimentary rocks identified in the study area and its vicinity include Pamaluan Formation, Warukin Formation, and the North part of the area is occupied by Haloq Formation. Pamaluan Formation consists of sandstone intercalated with claystone, shale, marl, siltstone, tuff, coal, iron oxide and lenses of limestone. The rock Formation is formed at Upper Oligocene to Lower Miocene and deposited in a neritic environment. The Warukin Formation consists of quartz sandstone intercalated with siltstone and carbonaceous clay. The age of the formation is interpreted from Middle Miocene to Upper Miocene (Supriatna et al., 1995).

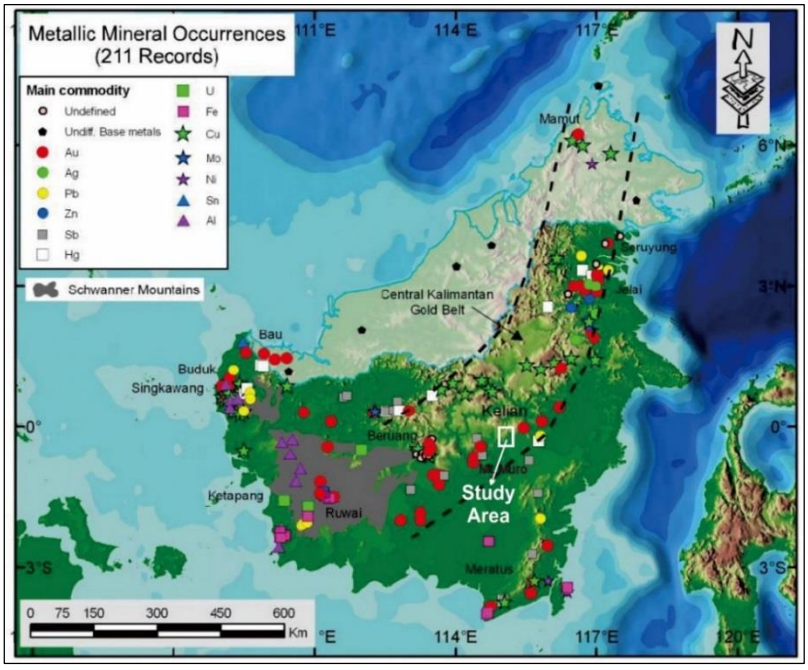

Fig. 1. Location map of research area in Lakan Bilem, Nyuatan district, which is identified as placer gold prospect situated within the central Borneo gold belt (modified from (Setijadji et al., 2010)).

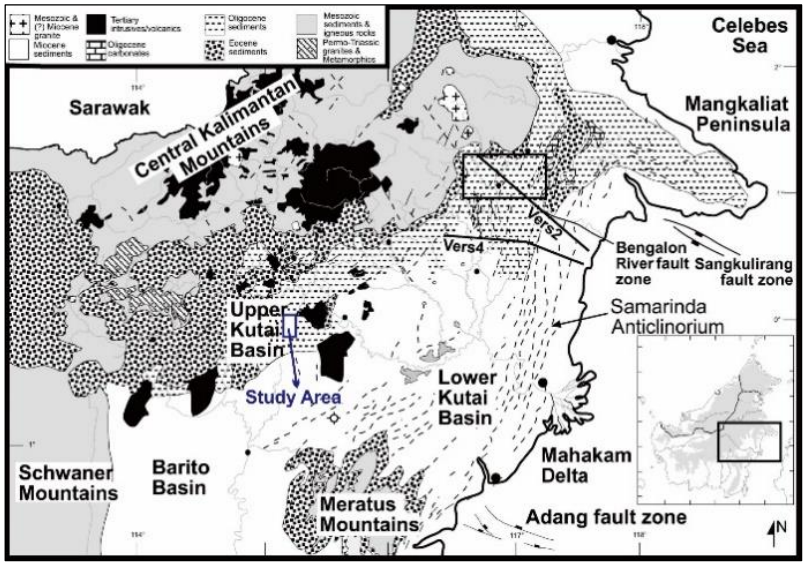

Fig. 2. Regional geology of Lakan Bilem and the surrounding area as the part of Upper Kutai Basin (modified from (Chambers et al., 2004)).

3. Research Methods

This study was started by field observation followed by laboratory analysis and potential estimation. The field observation was done by geological mapping in the study area and sampling was done by digging the alluvium deposit in some small rivers. Moreover, sampling was also done by making 5 test pits where each pit has 3 m depth. The observation and sampling location is indicated in map (Figure 3). Alluvial material taken from sampling points was panned to identify the mineral content in the concentrate especially gold.

The estimation of placer gold resources/ potential was based on the level of general exploration to achieve the indicated resources according to *Standard Nasional Indonesia* or SNI-4726 (JORC, 2012; Standar Nasional Indonesia (SNI) 4726:2011, 2011). The mass of gold was estimated based on gold grain size from the binocular microscopic analysis at Universitas Gadjah Mada. Various mineralogy and characteristics of gold grains were also observed by using a binocular microscope. Alluvium gold grade is normally stated as g/m^3, therefore, the weight of each sample needs to be converted to this unit. The samples were taken by a bucket which has volume 5 liters. From the samples point, there were two categories of samples. Sample labeled as A (example PC-A1; PC-A2), the number of deposits that panned was 4 buckets which equal to 20 liters. On the other hand, the samples categorized as B code (example PC-B1, PC-B2, etc.). The amount of panned material was 2 buckets which equal to 10 liters. The grade estimation of the placer gold deposit (in g/m^3) is stated Equation 1.

Grade (g/m^3) = weight of the gold grain x (1000/the amount of panned material in liters) (1)

Next step is estimation of the resources or potential of the placer gold deposit by using the formula in Equation 2.

Potential or resources (t) = grade (gr/m^3) x volume of the deposit (m^3). (2)

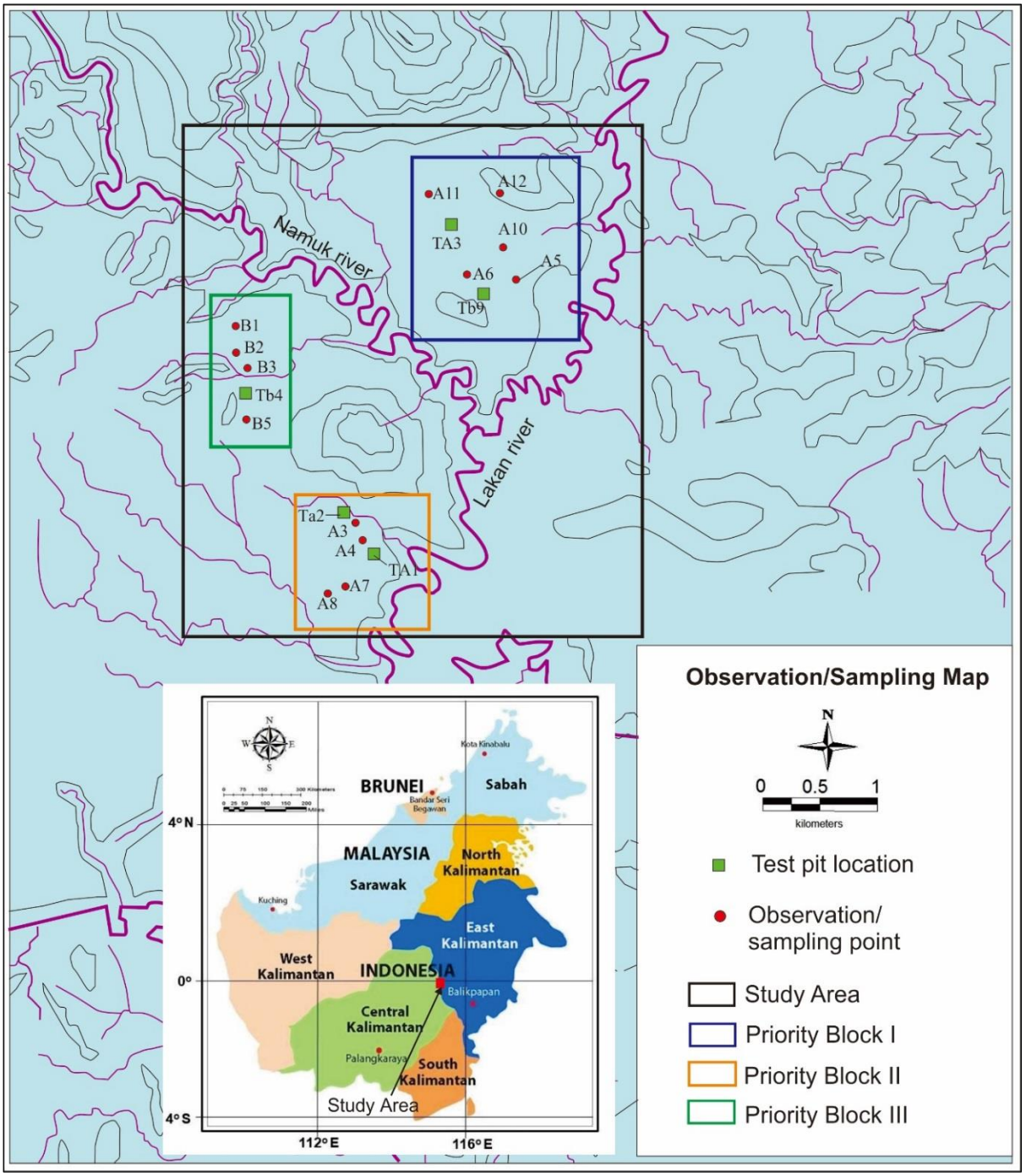

Fig. 3. Observation/sampling location map. Samples were taken from the alluvial deposit. Index map is sourced from www.google.com (2022).

4. Result and Discussion

4.1 Geology of The Study Area

The study area consists of gentle slope topography that varies from low to middle undulating hill. The main river of the prospect area flows relatively in direction north-south, the Namuk River flows from northwest to southeast and joins with Lakan River in the center of the area. Lithology units observed in study area are dominantly comprised of quartz sandstone and carbonaceous claystone. The quartz sandstone is characterized by grey colored, poorly sorted, with grain size from fine sandstone to gravel. The carbonaceous claystone has characteristics of grey- colored, fine grained with the composition of clay and carbonaceous material (Figure 4). The strike and dip of the rocks unit are interpreted to have a direction of strike northwest-southeast and dipping to the southwest. Based on the observation of its characteristics, the quartz sandstone in the study area is interpreted to a part of Warukin Formation which formed in Middle Miocene to Upper Miocene (Carlile and Mitchell, 1994; Supriatna et al., 1995; Wahyudiono, 2017).

The andesite intrusion was observed cutting the quartz sandstone (Figure 4). The andesite has characteristics of dark grey colored, porphyro-aphanitic, with mineral contents of pyroxene and plagioclase phenocrysts and aphanitic groundmass (Pellant, 2021). The magnetite was found in the panned concentrate as an accessory mineral of the andesite. Soerja-Atmaja et al., (1999) stated that the volcanic rocks series from Central Kalimantan belt is the product of calc-alkaline magmatism in the Early Tertiary (Carlile and Mitchell, 1994; Soeria-Atmadja et al., 1999). The K/Ar dating was performed for andesite samples collected from area between Kelian and Mt. Muro showing the age of 22.9 ± 0.5 Ma. The

geochronological result of the volcanic rock represents a phase of Late Oligocene-Early Miocene calc-alkaline magmatism (Soeria-Atmadja et al., 1999; van Leeuwen, 2015).

Fig. 4. The outcrop of the quartz sandstone with carbonaceous claystone (A) and andesite (B) in the study area.

The alluvial deposit was the youngest lithological unit observed in the study area. The alluvial deposit is distributed following the drainage pattern that composed by fragments and matrix. The fragments of the alluvial deposit are dominated by quartz, whereas the fragments of igneous and metamorphic rocks were less abundant.

4.2 Placer Gold Characteristics

The gold deposit in general classified as 2 types namely primary gold and secondary gold deposit. The primary gold deposit mainly associated with magmatic processes which the examples of the deposit such as epithermal, porphyry, and volcanic massive sulphide (VMS) deposit. On the hand, secondary gold deposit which one of them identified as placer deposit is formed by mechanical concentration of the resistant and high specific gravity mineral from the weathered source rock. Gold has high specific gravity (15.5 – 19.4) accumulated from the primary gold deposit by the flowing of water such as fluvial or marine processes (Arndt et al., 2017, 2015; Moon et al., 2006). The gold in the research area was found in alluvial deposit which formed from the fluvial process.

Alluvial deposit in the concession area is divided into semi-consolidated alluvial and unconsolidated types. The first type is a paleo alluvial deposit, which is interpreted as gold bearing sediment with the thickness of around 0.5 m (Figure 5). The second alluvial deposit is a modern sediment which doesn't contain gold.

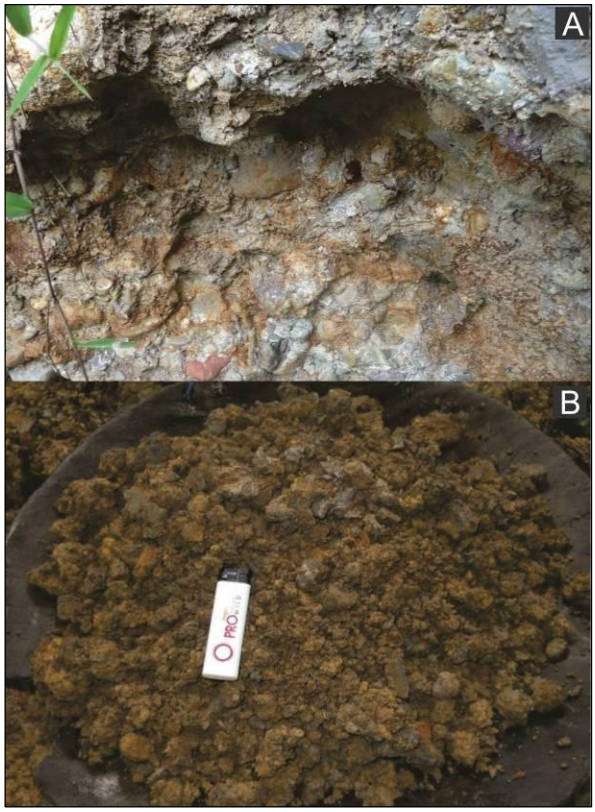

Fig. 5. (A) The outcrop of the semi consolidated paleo alluvial deposit as the gold bearing sediment which predominantly consist of quartz fragment, matrix supported with composition quartz and clay minerals, (B) the mined material which is ready to be panned.

Laboratory analysis of the placer gold grain from study area was conducted using binocular microscope for the concentrate of panning samples (Figure 6). The result shows that the minerals in the concentrate predominantly consist of ilmenite at 30 - 65% volume of the sample. The characteristics of the ilmenite are black, metallic luster, rounded shaped with the grain size of around 0.1 to 2 mm. The second abundant mineral is magnetite of 10 -25% volume, which is typified by black colored, metallic luster, rounded shape, short prismatic, granular and ferromagnetic. The other mineral identified is zircon which displays long prismatic shaped, transparent and dominantly pink in color or colorless, and grain size varying between 0.1and 1.5 mm. Quartz also identified as colorless mineral and has abundance proportional to ilmenite.

The gold in the samples consist as trace mineral. Gold grain identified using microscope shows characteristics of yellowish gold colored, dominant platy and tabular shapes, as well as coarse and angular surface textures. The grain size of gold is typically ranging from 0.1 to 1.2 mm (Figure 6). Based on the gold morphologies including platy, angular and coarse surface, it may indicate that the process of gold deposition is predominantly controlled by hydrodynamic transportation at a relatively moderate regime (Alam et al., 2019; Girard et al., 2021; McLachlan et al., 2018; Wierchowiec, 2002).

The study area is a part of central Kalimantan gold belt which hosts Cenozoic Au-Ag epithermal Low – Intermediate Mineralization (van Leeuwen, 2018) The placer gold prospect in the study area is located in the west of Kelian gold deposit which is confirmed as the intermediate epithermal deposit (Idrus and Prihatmoko, 2021; John et al., 2018; van Leeuwen, 2015). It may suggest that the primary gold deposit in the study area is of a low – intermediate epithermal gold type.

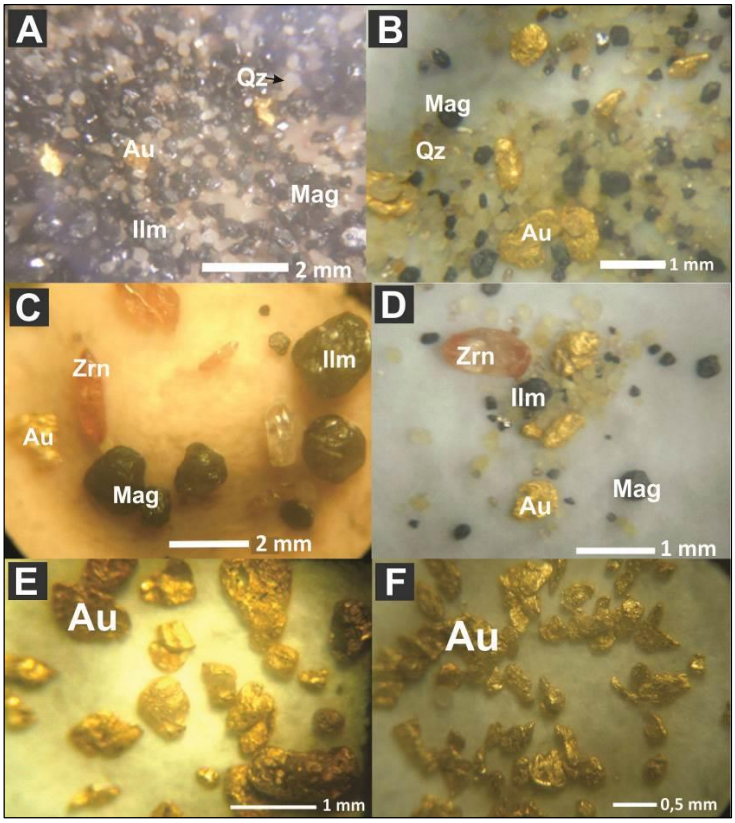

Fig. 6. The minerals consist in panned samples identified using binocular microscope. Ilmenite (Ilm), magnetite (Mag), Zircon (Zrn), and Quartz (Qz) observed as dominant minerals. The gold (Au) consists as trace mineral showing yellowish gold colour also platy and tabular shaped.

Table 1. The estimated indicated resources value from placer gold deposit in the study area.

Sample Code	Mass of the gold (mg)	Material volume (m^3)	Gold content (g/m^3)	Indicated Resources (t)
BLOK I (L = 97.5 Ha or 975,000 m^2; Average thickness= 2.2 m)				
PC-TA3	18.2	0,02	0.99	
PC-A5	9.5	0.02	0.47	
PC-A6	1.6	0.02	0.08	
PC-A10	9.9	0.02	0.50	
PC-A11	25.0	0.02	1.25	Block volume = 975,000 x 2.2 = **2,145,000** m^3
PC-A12	34.1	0.02	1.71	
PC-TB9	29.2	0.01	1.92	
		Average content	**0.98**	**2.1**
BLOK II (L = 55.8 Ha ore 558,000 m^2; Average thickness = 2.1 m)				
PC-TA1	17.5	0.02	0.87	
PC-TA2	3.1	0.02	0.16	
PC-A3	10.5	0.02	0.53	
PC-A4	44.4	0.02	2.22	Block volume = 558,000
PC-A7	24.3	0.02	1.22	x 2.1 = **1,171,000** m^3
PC-A8	44,8	0.02	2.24	
		Average content	**1.21**	**1.42**
BLOK III (L = 50,4 Ha or 504.000 m^2 ; Average thickness = 2.0 m)				
PC-B1	9.1	0.01	0.91	
PC-B2	3.9	0.01	0.39	Block volume = 504,000
PC-B3	4.2	0.01	0.42	x 2.0 = **1,008,000** m^3
PC-TB4	40.0	0.01	4.00	
		Average content	**1.43**	**1.44**
The Total of Indicated Resources				**4.96**

Note: The average thickness for each block is based on field observation and drilling data from the previous exploration activity.

4.3 Placer Gold Potential

The potential or resources of the placer gold deposit in the study area is estimated based on general exploration level, therefore, the resource is categorized into an indicated resource (JORC, 2012; Standar Nasional Indonesia (SNI) 4726:2011, 2011). The potential/ indicated resources of three blocks of exploration target within the study area were estimated. The grade of the alluvial gold is normally stated in g/m^3 so the

concentrate from the panning activities which are noted as liter, converted into g/m^3 unit. In this study, the samples taken and coded as A has volume 20 l for each sampling point, while from the zone B the volume of samples taken was l0 l for each sampling point.

Potential/ indicated resources of placer gold in three blocks within the study area were estimated (Table 1). Block 1 contains 2.1 t gold, Block 2 hosts 1.42 gold, and Block 3 has 1.44 t gold, and the total is 4.96 t gold.

The recommendation of the next exploration is providing more drilling location. The drilling plan with gridding method with the space of each point of 100 meters. The suggestion of the priority block of drilling location based on the accessibility to the location even though the gold population mostly found in Priority block II. The expected result of the grid drilling is lateral and vertical distribution of the mineral deposit (Hadar, 2018; Moon et al., 2006). The drilling data also will upgrade the confidence level of the resources from indicated resource to the measured resources (Standar Nasional Indonesia (SNI) 4726:2011, 2011).

5. Concluding Remarks

The Gold Deposit from the Lakan Bilem Block, Nyuatan sub-district, West Kutai district, East Kalimantan is a placer gold deposit that deposited from paleo semi consolidated paleo alluvial deposit. The microscopic observation shows the characteristic of the gold which is predominantly platy shaped, some of them tabular, coarse surface texture, with angular tip indicating the source of the gold relative moderate. The study area is located in the Central Kalimantan Gold Belt, which is confirmed as a low-intermediate epithermal deposit, so the source of the placer deposit in the Lakan Bilem block is interpreted from the epithermal deposit.

Acknowledgements

The research was supported by PT. Nugraha Insan Kencana Mining (PT. NIKM). The Author would like to thank you to the company for their permission to do the fieldwork, and take the samples for the analysis.

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