PRELIMINARY STUDY ON OROGENIC DEPOSIT TYPE AS A SOURCE OF PLACER GOLD AT BOMBANA, SOUTHEAST SULAWESI, INDONESIA

Arifudin IDRUS[1*], Akira IMAI[2], Andi MAKKAWARU[3], KAMRULLAH[3], I Wayan WARMADA[1], Irzal NUR[4] and Rohaya LANGKOKE[4]

[1]Department of Geological Engineering, Gadjah Mada University, Indonesia
[2]Department of Earth Resources Engineering, Kyushu University, Japan
[3]Energy & Mineral Resources Agency of Southeast Sulawesi, Indonesia
[4]Department of Geological Engineering, Hasanuddin University, Indonesia
*Corresponding author: *arifidrus@ugm.ac.id*

ABSTRACT

In Indonesia including Sulawesi Island, gold reserves and production is mostly derived from volcanic-related hydrothermal deposit types particularly epithermal, skarn and porphyry. It is due to this nation situated along some major magmatic arcs, e.g. Sunda-Banda, Irian Jaya (papua) and western-northern Sulawesi. However, other potential gold deposit types may also present. In Langkowala area (Bombana Regency), southeast Sulawesi, placer gold has been discovered in 2008 and more than 60,000 traditional gold miners in the early 2009 have been operated by making vertical pit and panning active stream sediment in this area. The grade of placer gold ranges from 50 to 140 g/t. Local geological framework indicates that the placer gold may not be related to epithermal, skarn or porphyry system. This paper describes a preliminary study on possible primary deposit type as a source of the Langkowala (Bombana) secondary placer gold. As a result, on the basis of field investigation and chemical analysis, the Langkowala (Bombana) placer/paleoplacer gold is possibly related to gold-bearing quartz veins/veinlets hosted by metamorpcic rocks (particularly mica schist) in the area. These quartz veins/veinlets were recognized in metamorphic rocks at Wumbubangka Mountain, a northern flank of Rumbia Mountain Range. The similar quartz veins/veinlets are also probably present in Mendoke Mountain Range in the north of Langkowala area. Sheared, segmented quartz veins/veinlets are of 2-20 cm in width and contain gold in grade varying between 2 and 61 g/t. This primary gold deposit is called as 'orogenic gold type' (cf. Groves et al., 1998; 2003). Orogenic gold deposit could be a new target of gold exploration in Indonesia in the future.

Keywords: *Placer gold, orogenic gold deposit, Bombana- Southeast Sulawesi, Indonesia.*

INTRODUCTION

Indonesia is a biggest gold producer in Southeast Asia. Currently, gold is mostly mined from volcanic-hosted hydrothermal deposit types including epithermal type e.g. Pongkor in West Java (Warmada, 2003), Gosowong in Halmahera Island, skarn type e.g. Erstberg, Kucing Liar, Deep Ore Zone (DOZ) in Papua, and porphyry type e.g. Batu Hijau in Sumbawa Island (Idrus et al., 2007; Imai & Ohno, 2005) and Grasberg in Papua. In Sulawesi Island, gold is predominantly related to volcanic rocks, which are extended along western and northern Neogene magmatic arcs of the island (Idrus, 2009). However, gold has also been found in Southeast arm of Sulawesi Island, particularly in Bombana Regency (Fig. 1), in form of placer and paleoplacer. Gold grain was firstly discovered in stream sediment of Sungai (River) Tahi Ite in 2008, and more than 20,000 traditional gold miners have been operated in the area (Kompas Daily, September 18, 2008). During January 2009, the number of traditional gold miners in Bombana Regency increases significantly and reached the total of 63,000 people (Surono & Tang, 2009). The secondary gold is not only found in present stream sediment (placer), but also found within Miocene sediments of Langkowala Formation (paleoplacer). The primary source of Bombana placer/paleoplacer gold is in controversy and still opens for discussion. This paper describes a preliminary study on possible primary deposit type as a source of the Langkowala (Bombana) secondary placer gold. This study is an important stage for the next exploration of gold in the area or other areas that have identical setting of geology.

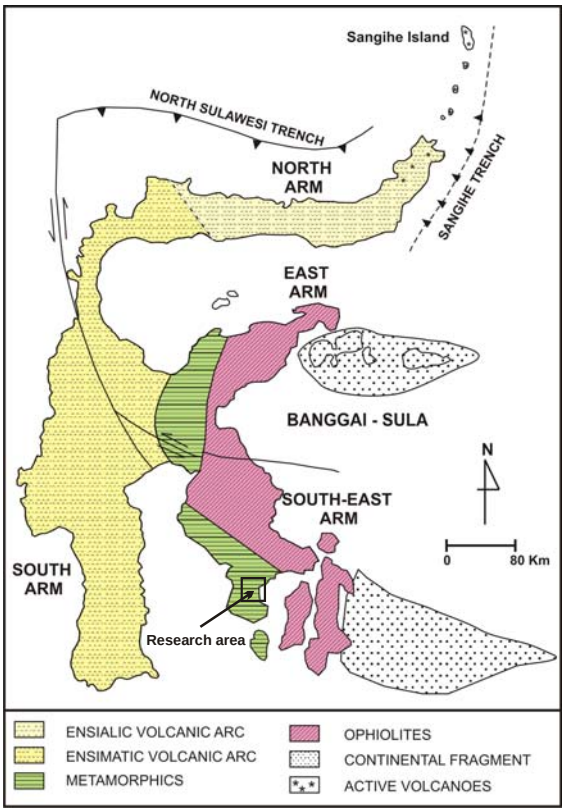

Figure 1 Geological setting of Sulawesi Island (modified from Hamilton, 1979) and location of research area in Bombana Regency, Southeast Sulawesi.

GEOLOGIC BACKGROUND

Langkowala area where placer gold found is characterized by wavy-flat morphology and crosscut by some major rivers including Langkowala River, Lausu River, Lebu River and Pampea River. Langkowala area is located between Mendoke Mountain in the north and Rumbia Mountain in the south. Langkowala area is occupied by Early Miocene Langkowala Formation (Tmls) consisting of conglomerate and sandstone (Simandjuntak et al., 1993). This Formation is a part of Sulawesi Molasses, which were firstly described by Sarasin & Sarasin (1901) in Surono & Tang (2009). Langkowala Formation is unconformably overlain by Paleozoic metasediments and metamorphic rocks (Pompangeo Complex, Mtpm) and conformably underlain by Eemoiko Formation (Tmpe), which is composed of limestone-marl-sandstone intercalation and Boepinang Formation (Tmpb), which is composed of sandy claystone, sandy marl and sandstone. Paleozoic metamorphic rocks consist of mica schist, quartzite, glaucophan schist and chert. The metasediments and metamorphic rocks are of Perm-Carbon in age and occupy the Mendoke and Rumbia Mountains. Mica schist is commonly characterized by the presence of quartz veins/veinlets ranging between 2 and 20 cm in width. Geological map of Bombana area are shown by Fig. 2.

RESEARCH METHODS

As outlined before, this is a preliminary study, which is initiated by desk study, fieldwork and sampling. There are no previous studies in the area especially focusing on the primary gold mineralization as a source of the secondary gold. However, during desk study few literatures related to Bombana secondary gold were reviewed, e.g. Makkawaru & Kamrullah (2009) and Surono & Tang (2009). The initial fieldwork was focused on the reconnaissance of studied area and sampling. Few stream sediment and quartz vein samples were taken to be geochemically analyzed in laboratory. X-Ray Fluorescence (XRF) has been used for the whole-rock geochemical analysis of the samples taken.

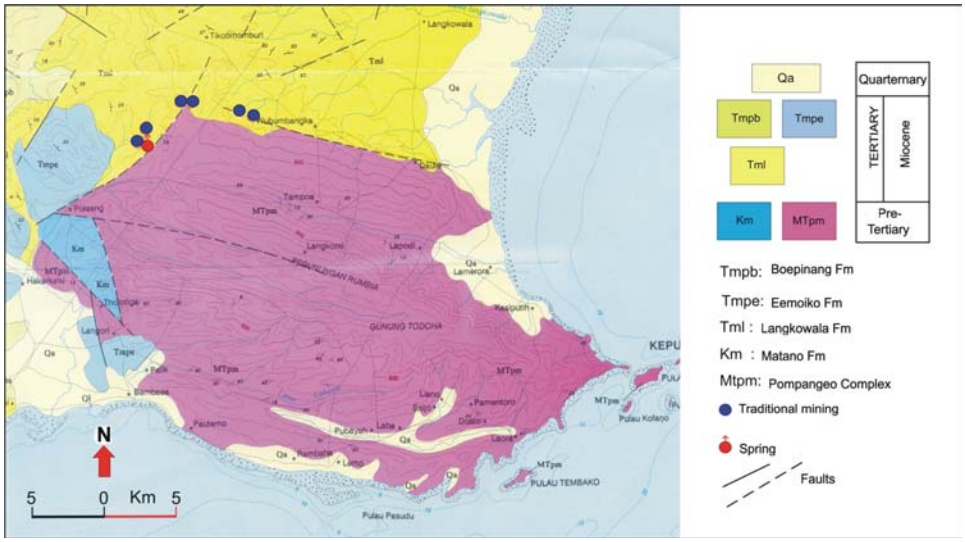

Figure 2 Geological map of Langkowala area occupied by Langkowala Formation (Tml) and unconformably overlain Paleozoic metamorphic rocks (Pompangeo Complex; Mtpm) in the south (Wumbubangka and Rumbia Mountain Range) as well as Mendoke Mountain Range (not appear in the map) in the north (Modified from Simandjuntak et al., 1993).

LANGKOWALA PLACER GOLD

Gold grain is present both in stream sediment of the present-day active rivers and in Tertiary sediment of Langkowala Formation. Up to now, a huge number of traditional gold miners are still operated by making 3-6 m vertical pit to dig out the material of Langkowala Formation and by panning the active sediment to recover gold grain (Fig. 3). Some miners combine panning with sluice box method for recovering more gold. Gold location plotting indicates that placer gold is distributed not so far from metamorphic mountain range. A relative short distance of gold transportation is consistent with subrounded-angular form of gold grain panned (Makkawaru & Kamrullah, 2009). Preliminary data also exhibits that the abundance of gold grain decreases as its distance from the metamorphic mountain range increases. Geochemical analysis using XRF of 6 soil and stream sediment samples taken indicates that gold (Au) grade ranges from 50 g/t to 140 g/t (Table 1). Base metals including Cu, Zn, Pb and other elements such as As, Zr, S, Ti, V, K, Ca are relatively low, with exception of Fe grading between 4.06 and 7.89 wt.%. The low content of base metals and S may imply weak mineralization of base-metals-bearing sulphides in the primary deposit.

Figure 3 Traditional gold miners recover gold grain (nugget) from active stream sediment by digging and panning.

Table 1 Chemical data (XRF) of gold and other metals in stream sediments at Langkowala area, Bombana Regency (Grade unit of elements is in g/t, except Fe in wt.%).

No.	Elements	Samples Code						
		A.001	A.002	A. 003	B. 001	B. 002	C. 001	C. OO2
1	**Au**	**100**	**50**	**60**	**130**	**110**	**140**	**120**
2	Cu	70	50	80	120	80	90	50
3	As	50	20	50	220	60	180	140
4	Zn	70	87	50	120	120	200	100
5	Zr	70	40	70	110	100	40	70
6	Pb	40	20	30	40	40	20	10
7	S	10	20	107	20	10	170	30
9	Fe	6.69	4.06	4.19	4.77	5.46	7.89	5.44

IS OROGENIC DEPOSIT TYPE AS A SOURCE OF PLACER GOLD?

Preliminary field investigation shows that gold-bearing quartz veins/veinlets have been discovered in association with Paleozoic metamorphic rocks in Wumbubangka Mountain, the northern flank of Rumbia Mountain Range. Quartz veins/veinlets range between 2 and 20 cm in width. Quartz veins/veinlets are mostly sheared/deformed and relatively parallel to the foliation of the mica schist (Fig. 4a and 4b). Some quarzt veins/veinlet may crosscut the foliation. The quartz veins have been sigmoidal segmented in form of 'boudin-like' parallel to the foliation of the metamorphic rocks. Quartz veins occasionally shows en enchelon in shear zone. Megascopic observation shows that quartz veins/veinlets contain few fine-grained sulphide minerals and metamorphic rocks are weakly altered to clay-silica-pyrite. Ore chemical analysis of two selected quartz vein samples from Wumbubangka Mountain with three times repetition of analysis displays a various grade of gold ranging between 2 and 61 g/t, whereas base metals Pb and Zn grades are relatively low (Table 2). Fe grade is relatively high averaging 5.14 wt.%. This is consistent with the concentration of base metals in the soil/stream sediments. High Fe concentration is typical in the metamorphic wallrock of quartz veins/veinlets (cf. Groves et al., 2003).

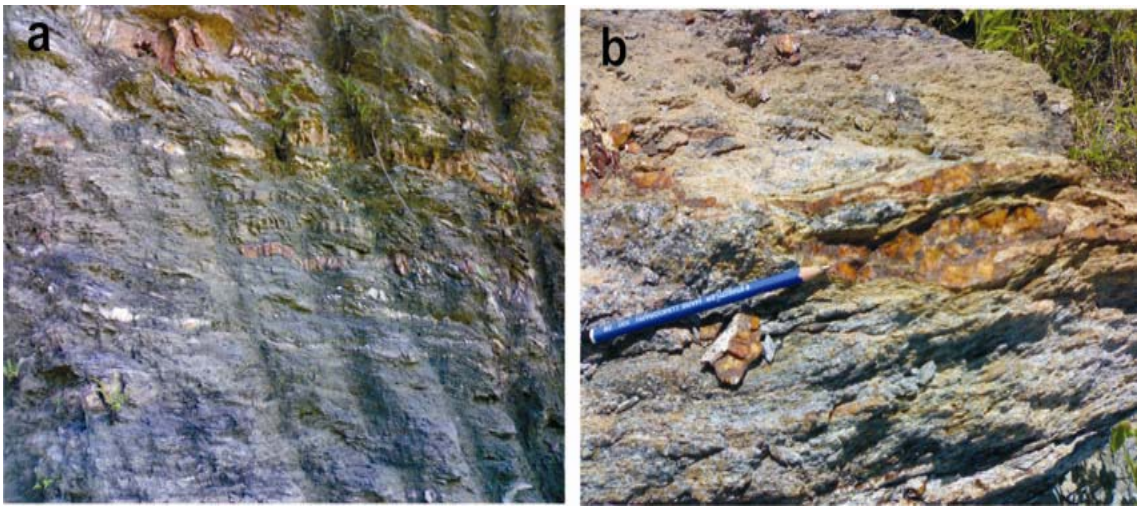

Figure 4 Sheared/deformed gold-bearing quartz veins/veinlets hosted by metamorphic rock (mica schist) found in Wumbubangka Mountain, the northern flank of Rumbia Mountain Range: (a) numbers of 2-20 cm wide of sheared, segmented quartz veins/veinlets, which are relatively parallel to the rock foliation, and (b) closed up of oxidized 'boudin-like' quarzt vein in mica schist.

On the basis of field data, it is interpreted that secondary (placer) gold in Bombana may be derived from "orogenic gold", a hydrothermal deposit type for describing sheared gold-bearing quartz veins, which are hosted by metamorphic rocks particularly green schist (cf. Groves et al., 1998). The presence of gold-containing quartz veins/veinlets hosted by Wumbubangka (Rumbia) Mountain in the south part of Langkowala area supports this interpretation. Field/megascopic appearances of gold-bearing quartz veins/veinlets meet the criteria of orogenic gold type, however some laboratory analysis particularly fluid inclusion of quartz veins/veinlets and metamoprphic facies study are crucial to be done for a better understanding of the deposit type. The presence of gold-bearing intrusion is not necessarily outcropped on the surface. Hydrothermal fluid-derived intrusion in many cases of orogenic gold deposit is mostly buried subsurface. Shear zone is an important geological aspect as channelways for ascending of hydrothermal fluids responsible for the formation of the gold deposit.

Table 2 Chemical data (XRF) of sheared gold-bearing quartz veins hosted by mica schist in Wumbubangka Mountain at northern flank of Rumbia Mountain Range in the south of Langkowala placer gold location.

No.	Samples Code	Analysis Repetition	**Elements** (in g/t, except Fe in wt.%)					
			Au	**Zn**	**As**	**Pb**	**S**	**Fe**
1	Sample 1 (Quartz vein in Wumbubangka Schist)	1	**3**	8	2	7	-	6.60
		2	**2**	7	2	8	-	6.57
		3	**2**	7	2	7	-	6.55
2	Sample 2 (Quartz vein in Wumbubangka Schist)	1	**61**	6	4	3	20	3.73
		2	**58**	6	3	3	25	3.76
		3	**60**	5	5	3	27	3.60

CONCLUSIONS

On the basis of this preliminary study, some points are concluded as follows:

1. Secondary (placer) gold in Langkowala area (Bombana Regency) occur in two styles including (1) placer gold in active stream sediment of rivers cutting Langkowala area, and (2) paleoplacer gold hosted by Early Miocene Langkowala Formation (Tmls), which is dominated by conglomerate and sandstone.
2. It is interpreted that the primary source of secondary (placer) gold is orogenic gold deposit type in form of sheared/deformed quartz veins/veinlets hosted by metamorphic rocks particularly mica schist (member of Pompangeo Complex; Ptpm) occupying Rumbia Mountain including Wumbubangka Mountain in the south and probably Mendoke metamorphic mountain range in the north.
3. Highest abundance of gold is commonly discovered near slope and spurs of metamorphic mountain range including Wumbubangka Mountain, a northern flank of Rumbia Mountain range. The abundance of gold grain decreases as its distance from slope/spurs of the metamorphic mountain range increases. This may imply that gold grain was not so far transported from its primary source.

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